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Discussion Paper on Coal

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FOREWORD

We Canadians approach our energy future from a position of inherent strength. Unlike many other industrial nations we are a net supplier of energy to the world, not a net importer; we produce in Canada more energy than we consume. This has placed us in the special position where we have a number of energy alternatives for the future, and the time to choose wisely among them.

One of these alternatives is coal, and to promote full public consideration of that particular option I have asked my Department to prepare this discussion paper. It is one of a series of such papers designed to support a broadly based discussion of Canadian energy alternatives.

This paper canvasses an array of coal options that can be matched to other energy alternatives. One of these is that coal should recapture its place as a major national energy fuel—a position that it lost to other fuels, especially oil, in the 1950s. This would involve the displacement of oil used in electrical generation and the increased use of coal in traditional coal-to-electricity processes; the application of coal to new uses such as increasing yields from tar sands; and an expanded role for Canadian coal in world coal markets, especially through thermal coal exports in traditional or possibly upgraded forms. And there are other choices, as the paper describes.

Technological requirements of the various coal options are identified here. The paper emphasizes that environmental considerations must be an intrinsic component of any coal option chosen, and outlines some of the coal industry's transportation problems. Coal is depicted as providing between 12 and 18% of our total primary energy requirements in Canada by the year 2000.

In debating the various possibilities for the use of coal in the future, Canadians will want to weigh the opportunities and costs of each of the options—be they economic, social or environmental. I look forward to this debate, and have asked my Department to elicit public responses to this and other papers in the series.

MARC LALONDE
Minister
Energy, Mines and Resources Canada

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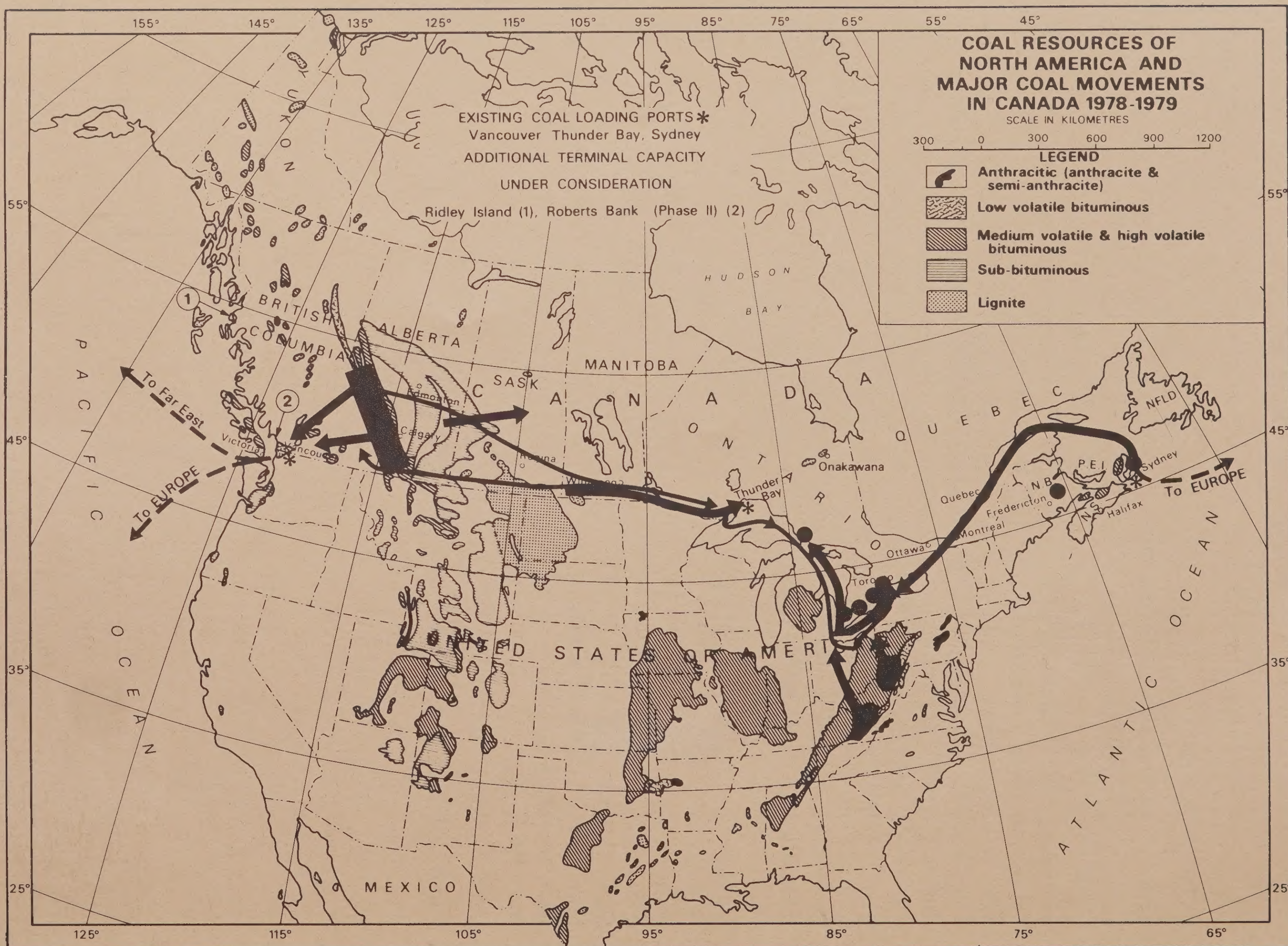


COAL RESOURCES OF NORTH AMERICA AND MAJOR COAL MOVEMENTS IN CANADA 1978-1979
SCALE IN KILOMETRES
300 0 300 600 900 1200
LEGEND
Anthracitic (anthracite & semi-anthracite)
Low volatile bituminous
Medium volatile & high volatile bituminous
Sub-bituminous
Lignite
EXISTING COAL LOADING PORTS *
Vancouver Thunder Bay, Sydney
ADDITIONAL TERMINAL CAPACITY
UNDER CONSIDERATION
Ridley Island (1), Roberts Bank (Phase II) (2)
YUKON
BRITISH COLUMBIA
ALBERTA
SASK
MANITOBA
ONTARIO
QUEBEC
CANADA
NFLD
P.E.I
N.B
N.S
HUDSON BAY
UNITED STATES OF AMERICA
MEXICO
PACIFIC OCEAN
ATLANTIC OCEAN
To Far East
To EUROPE
To EUROPE
Victoria
Vancouver
Edmonton
Calgary
Thunder Bay
Onakawana
Toronto
Ottawa
Montreal
Quebec
Fredericton
Halifax
Sydney

INTRODUCTION

This paper describes the main characteristics of the Canadian coal system which, largely because of the geographical distribution of the coal producing and consuming districts, tends to be quite different in many important respects from the situation in other major coal-producing and coal-using nations. The paper endeavors to set out the role coal could play in the coming years and to probe the opportunities and difficulties associated with its increased use. Its main object is to identify and illuminate the more important choices before us.

An attempt has been made to discuss some of the major factors related to the coal system as a basis for consideration of broad coal policy questions. While these factors can be readily identified, the magnitude of their impact on the coal system is difficult to predict. It is also very hard to forecast how much coal will be produced and used in Canada at any given time; because coal is seen, in some regions, as an energy source of last resort. Coal fills the gap between an increasingly uncertain energy demand and the supply from other easier-to-use sources, which are becoming less sure with time. Coal tends to follow the energy system—its markets are determined by factors outside the direct influence of the industry. It was easy to turn away from coal during the period of abundant and cheap oil and natural gas; it is much more difficult to convert back to coal because of the many transportation, environmental and utilization problems coal presents.

The coal system has little cohesion. The producers of coal are often waiting for the decisions of others who could utilize coal but have other choices to assess. The investment in the coal system is frequently heaviest at the utilization end—for electrical generation plants now and coal-conversion processes later. These coal utilization facilities are rarely controlled by the coal production industry.

Most coal other than that consumed at the mine site, moves at least part way by railroad. In contrast to oil, gas and electricity, the transportation facilities upon which the coal industry relies are not under its control.

The importance of coal in the Canadian energy economy will grow with production by the year 2000, possibly reaching three to five times the present level (1979) of 33 million tonnes. Canada has large resources of coal to support this production, and there is now a major interest in knowing how great a contribution the coal system could make to meeting Canada's energy needs under various conditions and how soon this contribution could be achieved.

Coal differs in importance throughout Canada. British Columbia sees expansion of its metallurgical coal production as a way to open important new regions of that province. Alberta relies upon coal as the basic source of energy for its fast-growing electrical supply option. Saskatchewan also relies upon coal

for electric power production. Nova Scotia sees its coal resources as an important element of both its energy and industrial development strategy. Five coal-producing provinces are actively concerned with coal policy development. Alberta, British Columbia and Saskatchewan have articulated explicit coal policies while Nova Scotia has treated coal as a basic element of its energy policy. Although New Brunswick is only a small producer and consumer of coal, it is also taking coal into account in its energy supply policy. Ontario, as a major coal consuming province, has taken an active interest in western coal developments. Important resources of coal may also exist in the Yukon and Northwest Territories.

Some provinces may opt, with considerable economic justification, for accelerated coal development. This will require increased emphasis on technology and infrastructure, as well as on health, safety and environmental protection. Provincial initiatives must be meshed within the context of an overall national energy strategy.

A number of recent international, national and corporate studies testify to the growing importance of coal as an international energy commodity. Most authorities agree that coal will provide the main alternative to oil in at least the short and medium terms. A major international market for thermal grades of coal is in its incipient stages of formation. The manner in which this market develops may well affect the reduction of world dependence on oil.

Canada is among the main coal trading nations, and there is good reason to believe that the Canadian presence in the international coal market will increase in the years ahead. While Canada now exports a high fraction of its coal production, it will become a net coal exporter in the next few years. It has had a trade surplus of the more valuable metallurgical coal for many years. At the same time Canada will continue to import coal at about the same level (with imports drawn almost entirely from the United States). How the international market will develop and how Canada participates in it will determine the extent to which coal produces another international energy "resource" to be drawn upon as circumstances warrant. Coal and coke enters and leaves Canada freely now as it does the United States; therefore, both countries can benefit from an international market for energy coals.

While coal will remain important in its principal markets—currently about 75% for electrical energy production and 25% for coke production used in steel-making—new uses for coal will become more important in the 1980s. In several applications, such as the production of liquids and gases from coal, Canada will share interest with many other countries. In such circumstances we may need only to update processes being developed by others to our own situation and resources. But for other applications, such as the use of coal in the oil sands and heavy oil recovery, it is possible that unique opportunities may arise. Present expenditures on coal R&D (research and development) by

governments and industry amount only to about $25 million a year, in contrast with American expenditures of over $700 million a year and major expenditures by other countries such as Germany, the United Kingdom and Japan. These latter expenditures reflect the growing emphasis on the demonstration level of activity. Canada must consider how best to pursue its technical requirements for coal as well as the general economic importance of coal.

The health, safety and environmental effects of increased coal production and utilization are becoming matters of increasing public concern since more and more of Canada's coal production originates from surface mines. The issue of reclamation is of prime importance in some regions. The release of sulphur and nitrogen oxides resulting from the combustion of coal and the contribution of these oxides to the acid rain phenomenon is of great concern even though other non-coal sources of these oxides are more important in the Canadian scene. International attention is focused on the possibility that increased release of carbon dioxide may cause higher world temperatures.

Coal's presence in the Canadian primary energy economy should grow from its present 9% (1979) level to at least 11 or 12% by the year 2000. This contrasts with the current dependence on coal of about 18% in the United States, 30% in West Germany, and about 78% in South Africa. If new uses for coal are found, coal could contribute as much as 18% of Canada's primary energy needs by the year 2000.

THE CANADIAN COAL SYSTEM

Coal's Present Role

The role of coal in the Canadian economy is complex. Much of the complexity is derived from three factors: (1) the geography of Canada, (2) the variety of alternative energy supply options available to Canada, and (3) the projected requirement of coal for use as an adjunct fuel in the extraction and processing of the oil sands and heavy oils of Alberta and Saskatchewan.

Most of Canada's coal resources occur in British Columbia, Alberta and Saskatchewan. While local markets are growing, this coal is distant from the established larger coal markets in the industrial regions of central Canada. The availability of other important energy resources in the western region—especially natural gas—limits the regional opportunities for coal. In Ontario on the other hand, the proximity to the Appalachian region in the United States has led to a continuing supply of both thermal and metallurgical grades of coal from that nation. In recent years, there has been an increasing flow of coal from western Canada to Ontario. Limited quantities of metallurgical coal are also shipped to Ontario from Cape Breton in Nova Scotia. This geographical distribution accounts for the unusual pattern of Canadian coal production and utilization as noted below:

- Only 9.3% of Canada's primary energy consumption in 1979 was supplied from coal, despite large resources of western coal that can be mined at attractive costs but which are expensive to transport to major markets in central Canada.

- Throughout most of this century, Canada has been a net importer of all types of coal. However, the growth of metallurgical coal exports, which began in the late 1960s, resulted in our becoming a net exporter of this coal by 1973. For a coal producing and consuming nation, Canada exports a relatively high percentage of its coal production—nearly 40% in 1979. In this same year, coal exports represented 1.3% of the value of all Canadian products sold abroad.

- Regional patterns of coal consumption vary widely, from 21% of Saskatchewan's primary energy supply being met from coal (the highest proportion in Canada) to essentially a negligible contribution in the case of Quebec. In Alberta, coal-fired generation presently supplies more than 75% of the province's electrical needs, and in accordance with that Government's announced policies coal is expected to supply about 95% in 2006.

- Mines are often established in Canada to supply coal exclusively to export markets on the basis of long-term contractual arrangements. In addition, Canadian interests have invested in United States mines to

secure long-term metallurgical and thermal supplies for Ontario markets.

- In 1979 the value of Canadian exports (FOB Vancouver) were $0.785 billion while the value of imports amounted to $1.033 billion.

Prospects for Coal

In Canada, coal fills in the cracks of an energy system still dominated by oil and gas. Estimates of requirements are subject to large uncertainties because the overall demand for energy is uncertain, and the extent to which more readily available (or suitable) fuels can fill that demand is also undetermined. Even where estimation should be the most straight forward— predicting the quantity of coal needed for electrical generation, the largest domestic market—it is difficult because the future demand for electricity is becoming more arduous to predict and the contribution from coal's leading competitor in that market—the nuclear system—is not certain.

Timetables for future coal deliveries are also difficult to assure because the supply system can be severely constrained by the actions of others over which the industry has little control. Concerted action by governments, railway companies and port owners together with the coal industry is required to build new rail lines and port facilities. Objection at any link of the chain can cause major delays, or even abandonment of projects.

Another important characteristic of the "coal chain" illustrates why difficulties in expanding supply are encountered. The capital involved in using coal for thermal generation plants and in other projected new uses for liquefaction and gasification is much larger than the investment requirements of the production phase. The utilization technologies are very different from those of the extraction stage, and these are invariably in the hands of customers who are often contemplating alternative fuel options. Different professions and expertise are involved. Normally, more time is required to build a utilization facility than to build the related coal supply system. The coal industry is constantly awaiting the decisions of others. Ownership patterns, largely for historical reasons, are different from, say, the oil and gas industry where large international firms undertake supply, transport and utilization within one organization. The vertically integrated system working "from the source to the customer's door" has the major advantage that not all individual links need be profitable; it is the overall performance that counts. The major domestic market for coal is the electrical utility industry, which is either provincially owned or regulated on a "cost-of-service" basis.

A major return to coal in the electrical generation market poses many problems. Even where an attractive economic case for coal expansion exists, such as replacing the oil used in many thermal power stations, the conversion from residual oil to coal tends to be technically difficult. Oil-fired boilers have

minimal facilities for removing bottom ash, and their tube spacing does not allow for "fly ash" in the hot gases. More space is required between the point of combustion and the heat interchange tubes in coal furnaces than in oil furnaces. Coal-fired stations need sufficient space for storing, handling and the preparation of the pulverized coal. Moreover, the question of applying sulphur containment technologies also arises even though in certain cases the sulphur-emissions on an energy content basis may actually be less when residual oil is replaced by low sulphur western coal. The containment technologies are not only expensive to build and to operate but also may require space that is not always easily available.

To overcome such technical difficulties in expanding coal for electricity utilization several alternatives exist. They include (in ascending order of capital cost requirements):

- Use of coal-oil mixtures (a technique that is still in the development stage);
- Pre-gasification of coal and supply of the energy to existing boilers as a low-energy gas (some technological uncertainties exist in this case, but these can be overcome with trials requiring one to two years); and
- Rebuilding the entire facility to accept coal.

Switching to coal by converting existing plants or building new facilities is invariably a difficult, slow, expensive and troublesome business, as compared to the original move away from the fuel in the past.

In a 1978 report prepared for EMR (Energy, Mines and Resources)—*Energy Futures for Canadians*—it was estimated that the coal consumption of 109 million TCE* (tonnes of coal equivalent) in the year 2000 would be 19% of the primary energy consumption in that year. This compared to the 30 million TCE consumption in 1979, which was 9.3% of the 8.9Q† consumed. A private study released in May in which EMR participated—*The World Coal Study*—presented three cases for Canadian coal. The base case forecast that consumption would vary between 82 and 121 million TCE by the year 2000. This estimated coal consumption was 16 and 20% of the 14.1 and 16.4Q primary energy consumption repectively for the three cases studied in the year 2000. Regardless of which estimate proves correct, it appears inescapable the large quantities of coal will be consumed in the future.

Canada's export trade is sensitive to international coal prices for all types of coal. The geography and geology of Canadian coal deposits, combined with the climatic conditions in which many mines must operate, often place these coals at a relative price disadvantage compared with other international

*TCE: 1 tonne of coal equivalent = 27.78×10^6 Btu.

†Q: Quads = 10^{15} Btu.

exporters. In addition, because of the great distances separating western Canadian deposits from eastern markets, Canada will likely remain an importer of coals throught this century. However, as prices in the United States and other international markets rise relative to Canadian costs, more Canadian coal is predicted to enter both domestic and international markets. The relatively high energy to sulphur ratio of western Canadian coals will be an increasingly attractive marketing factor and should enhance Canada's position an as international coal exporter.

LINKS IN THE COAL CHAIN

The Nature of the Resource Base

The coal resource base of Canada, appraised in 1978, is listed in Table 1 by coal class or rank. The resources of immediate interest consist of coal seams that, because of thickness, quality, depth and location, are considered to be the most attractive for exploration or exploitation activities. These resources exclude coal that may be present in the regions north of 60°N latitude (although small quantities of coal are produced from time to time in the Yukon Territory and elsewhere in the north), and minor occurrences known in Newfoundland and Manitoba.

As indicated in Table 1, Canada's measured coal resources of immediate interest are substantial. Measured lignite resources are estimated at 3,562 million tonnes, sub-bituminous resources at 30,000 million, high-volatile bituminous at 1,555 million, and low- to medium-volatile bituminous at 15,282 million tonnes. However, these estimates are conservative and should not be interpreted as the ultimate coal potential of the nation (see Glossary for definitions of coal resource terminology).

The data base used for quantitative estimation of Canada's coal resources has been generated principally by the following activities: exploration, development and mining undertaken by industry; geological investigations by provincial agencies and by the Geological Survey of Canada; and exploration programs in selected areas that have been funded largely by the federal departments of Energy, Mines and Resources and Regional Economic Expansion.

Table 1. ***Canadian Coal Resource Estimates, 1978***

	Resources of Immediate Interest			*Resources of Future Interest*		
Rank	*Measured*	*Indicated*	*Inferred*	*Measured*	*Indicated*	*Inferred*
	(million tonnes)					
Lignite	3,562	2,772	10,875	161	3,913	23,512
Sub-bituminous	30,000	—	102,000	—	—	198,000
High-volatile bituminous	1,555	559	8,457	3	50	128
Low- to medium-volatile bituminous	15,282	9,898	63,036	—	—	—

Source: *Coal Resources and Reserves of Canada*, Report ER 79-9, Energy, Mines and Resources Canada, Ottawa.

Generally speaking, Canada's coal resources are extremely large in relation to present coal requirements. If, for example, only 10% of measured coal resources of immediate interest were ultimately transformed into production, there would be enough lignite to last about 70 years; sub-bituminous—about 360 years, and bituminous—about 75 years (using 1978 run-of-mine production as a base).

While coal deposits occur in eight provinces, by far the largest resources are found in Alberta, British Columbia and Saskatchewan. With respect to the measured resources, 94% of the lignite, 100% of the sub-bituminous, 84% of the high-volatile bituminous and 100% of the low- and medium-volatile bituminous coals are located in these provinces.

Reserves and Supply

Coal reserves differ from resources in that the latter is geologically determined while the former refers to that portion of the measured and indicated resources which, after applying economic and technical criteria, are thought to be within the possibility of commercial exploitation.

The notion of reserves reflect the potential of a deposit rather than a specific tonnage available to satisfy demand. For example, if coal mining in the west is forced underground and underground miners are not available, then reserves are negligible. Another important consideration in interpreting reserves is that they have limited meaning when viewed in the aggregate state. Coal is a variable commodity containing different proportions of ash, moisture, volatile matter, fixed carbon, sulphur, etc. Coal may also vary in terms of its grindability, friability, swelling, fluidity and heat value.

Coal has many different end-uses depending on type—electrical generation, metallurgical application, liquefaction and gasification, etc.—depending on the quality of the product. Often the technology of end-use may be very "deposit specific" as for example the important case of designing thermal electric plants around the characteristics of certain lignite coals.

Theoretically speaking, the supply of coal is defined as the various quantities of a product per unit of time that sellers will place on the market at all possible alternative prices, all things being equal. As the price of coal rises therefore, reserves would approach resource levels. At any given time however, the actual reserves supplied to consumers would equal production plus or minus any stockpiled coal.

Table 2 attempts to demonstrate the volumes of coal involved in the process that transforms resources to reserves to production for a given year (1978). The mining methods used in coal extraction are also noted. (Beneficiation and transportation losses are not illustrated.) These figures should not be considered as a fixed quantity because the factors that determine the classification of coals are in themselves subject to continuing change. The most obvious

Table 2. ***Canadian Coal Resources, Reserves and Production (1978), by Area, Rank and Mining Method***

		Resources			*Reserves*						*Run-of-Mine Production in 1978*		
					Mineable Coal			*Recoverable Coal*					
Area	*Rank*	*Measured*	*Indicated*	*Total‡*	*Underground*	*Surface*	*Total*	*Underground*	*Surface*	*Total*	*Underground*	*Surface*	*Total*
							(million tonnes)						
British Columbia and Yukon	Bituminous	7,282	9,898	17,180	636	2,047	2,683	44+*	860+*	955	0.717[c]	2.173[a] 9.366[b]	12.256
	Lignite	1,845	91	1,936	—	839	839	—	397	397	—		—
Alberta†	Bituminous	9,300†	—†	9,300	986	1,471	2,457	148	382	530	1.839[c]	5.569[b]	7.408
	Sub-bituminous	30,000†	—†	30,000	1,347	5,981	7,328	n.a.	n.a.	2,182	0.032[c]	7.765[a] 0.513[b]	8.310
Saskatchewan	Lignite	1,499	2,681	4,180	—	2,150	2,150	—	1,720	1,720	—	5.058[a]	5.058
Ontario	Lignite	218	—	218	—	218	218	—	—	—	—	—	—
New Brunswick	Bituminous	32	16	48	—	46	46	—	33	33	—	0.315[a]	0.315
Nova Scotia	Bituminous	223	543	766	364	6	370	89	—	89	2.602[d] 0.205[c]	0.087[b]	2.894

*Figures are for low- to medium-volatile bituminous coal only. The remaining 51 million tonnes comprise high- to medium-volatile bituminous coals for which the proportion mined underground and on the surface is not available.

†Estimates for Alberta have not been prepared by EMR. The figures reported in this table are those reported by the ERCB (Alberta's Energy Resources Conservation Board). The ERCB's "established resources" are reported as EMR "measured resources" and it is recognized these figures include some undetermined amounts that EMR would report as "indicated" and/or "inferred". Furthermore, there is no ERCB category comparable to EMR "indicated". Such coal is either included in EMR "measured" or "inferred".

‡Excludes "inferred resources" because they are less certain and they are not considered as part of resource "pool" from which reserves are determined.
n.a.= Not available.

Source: *Coal Resources and Reserves of Canada,* Report ER 79-9, Energy, Mines and Resources Canada, Ottawa.

Mining methods:

a= dragline stripping

b= truck and shovel stripping

c= room and pillar

d= longwall

are relative energy prices, including coal prices themselves, transportation costs, technology, availability of the required inputs, and existing laws and regulations governing all stages of a coal development.

These factors change over time as does the magnitude of Canada's coal reserves. Also, for each specific end-use (linked to a given quality of coal) the quantity supplied at different marginal costs of production is subject to change. In the free trade environment for coal, in which Canada functions, these relationships are critical because we want to avoid transferring the advantages of low cost energy to other nations now, while reserving only the more expensive coals for domestic consumption later.

A few computer-based methods for deriving such information are being developed including one mining model at the Canada Centre for Mineral and Energy Technology—a branch of the EMR Western Mining Office in Calgary. The development of these models will allow for the integration of "replacement" considerations in coal resource-reserve management efforts.

The Ownership Characteristics of the Canadian Coal Industry

Ownership of Canada's coal resources and control of production is a continually evolving element of the Canadian coal industry. The coal resources are controlled by a mixture of private and public companies, private and public utilities, Crown corporations, and provincial and federal governments. This proprietorship has been characterized by change in response to provincial and federal needs and to market conditions.

Direct and indirect involvement by the provincial government in the coal industry has increased in recent years. The British Columbia government owns and is studying the Hat Creek deposit, one of the largest in Canada. Lignite deposits at Onakawana in Ontario are currently under study for development by the provincial government in co-operation with private interests. The New Brunswick government controls and mines coal in the Minto-Chipman area. Coal mining in Nova Scotia is dominated by DEVCO (the Cape Breton Development Corporation), a federal Crown corporation, although private concerns and the provincial government are also involved in coal mining.

Coal is a source of direct revenue for the provinces through royalty payments. This form of rent recapture has increased from nominal amounts as low as 6¢ a tonne in the 1960s to several dollars a tonne today. In Alberta the royalty payment is tied to profitability.

The industry is becoming regulated through provincial coal policy statements and environmental controls. It is no longer a simple matter to apply for and obtain a permit to mine. It may take several years after a preliminary disclosure by the developer before a decision is made. Federal government involvement is also on the increase as environmental issues along the Canada–United States border remain in dispute, and as foreign investment in

the industry expands and coal exports grow. Government involvement, especially for infrastructure requirements, is likely to continue to increase as the industry expands its production in new regions to meet growing demands.

It has already been shown that the coal industry is divided geographically into two sectors, one operating in western Canada and the other in the Atlantic provinces; both sectors supply a local, national and international market. During its early history most of the productive capacity of the industry was developed through regional investments and Government incentives, especially to overcome transportation costs. The renewed demand for coal and increased interest in Canadian development in the past decade, particularly in the western sector of the industry, has been characterized by an increasingly diversified ownership and control pattern. The western sector is controlled largely by privately-held and publicly-owned companies, whereas the eastern sector is controlled mainly by federal and provincial government Crown corporations. In Alberta and Saskatchewan, most thermal coal output is either directly or indirectly controlled by electrical utility companies; this dominance of the thermal coal trade is increasing and is projected to continue to increase well into the 21st century. For Canada as a whole, recent estimates indicate that approximately 10% of coal reserves of currently operating companies are controlled by the utilities and nearly 15% by Crown corporations.

The changes in provincial government legislation and regulations controlling the development of coal mines especially in the western sector, together with accelerating costs and the need for increasing amounts of risk capital, has induced and will continue to induce rapid structural change in the industry to meet these changing conditions. The trend is away from the small, privately-owned and operated mines to large, joint-venture consortiums, the partners of which may be the coal leaseholders, the producers and even the consumers of the coal produced. These development consortiums may represent major foreign as well as Canadian interests and may also include some form of participation by both federal and provincial governments, as in the proposed regional development of northeast British Columbia. Some foreign concerns are acquiring equity positions in future mine developments as the first step towards securing long-term coal supply contracts.

This great potential for coal development in Canada has drawn many new entrants into the industry, and has attracted not only traditional coal mining companies but also those with backgrounds in other areas of the mineral industry and with interests in energy commodities. Multi-national oil companies are becoming increasingly involved in coal mining activities in Canada and are now among the largest coal leaseholders. The resources of multi-national, as well as large Canadian mining companies, with their international marketing expertise, financial capacity and ability to spread risks over the long-term will be helpful in facilitating the adjustment of the Canadian industry in meeting

new coal demands of the 1980s and 1990s. It is important therefore to ensure that the prominent role of any one sector of the economy or foreign investors in the industry does not lead to a restriction of coal development or a reduction of competition within the industry.

Domestic Demand for Coal

Coal is consumed in Canada principally for the generation of electricity (about 75%) and for use in the steel industry (about 25%). Other industrial uses are currently small; however, changes in relative energy prices and in the technology of coal combustion can serve to enhance coal's economic attractiveness, vis-à-vis conventional fuels. New uses for coal-derived hydrocarbons, such as in the production of liquid fuels and synthetic gas, will also have the effect of increasing demand.

A summary of coal demand forecasts by end-use to the year 2000 follows.

Electric Utility Coal Demand

A survey of utility generating plans to the end of the century reveal a considerable re-emphasis on thermal coal. This is particularly true of Alberta, Saskatchewan, Ontario and Nova Scotia, and to a lesser extent New Brunswick and British Columbia.

Approximately 70% of Alberta's electrical energy production is derived from coal, Saskatchewan's about 67%, Ontario's about 26%, and Nova Scotia's about 17%. On a national basis about 15% of the country's electrical energy was produced from coal-fired stations.

Table 3. ***Utility Demand for Thermal Coal***

Province	*1980*	*1985*	*1990*	*1995*	*2000*
			(million tonnes)		
British Columbia*	—	—	0–13.4	0.3–13.4	0.9–13.4
Alberta	9.3	14.8	20.8	28.2	36.5
Saskatchewan	5.7	6.8	8.1	9.1	9.9
Manitoba	0.1	0.1–1.0	0.1–1.0	0.1–1.0	0.1–1.0
Ontario	12.1	11.7	12.1	15.6	19.0
Nova Scotia†	1.3	1.7	2.6–2.9	2.4–3.4	2.8–4.0
New Brunswick	0.5	0.5	0.5	0.5	1.0
Total	29.0	35.6–36.5	44.2–58.8	56.2–71.2	70.2–84.8

* High values based on the assumption of two stations coming on stream by 1990—one at Hat Creek, the other in the East Kootenays.

† Projections of Nova Scotia Energy Planning Organization, Halifax (1979).

A summary of utility demand for thermal coal by province appears in Table 3. These forecasts are based on current utility plans given certain expectations regarding the desirable energy mix (in particular nuclear power), relative fuel prices, technologies of utilization and electrical power demand.

Metallurgical Coal Demand

The major markets for metallurgical coal are Ontario's three steel companies and to a lesser extent at the Sydney Steel Corporation in Nova Scotia.

In Ontario, coking operations have been traditionally supplied with metallurgical coal from the Appalachian region in the United States. Recently some high-volatile coking coal has been shipped to Ontario mills from DEVCO mines (approximately 0.5 million tonnes a year).

Coke, for blast furnace uses, represents the highest single conversion cost item in steelmaking, and steel companies have been investigating alternative production processes that would minimize the amount of coke required to produce each tonne of hot metal. Metallurgical coal demand, therefore, depends on coke rates, the actual tonnage of steel produced and the state of steel making technology.

A consolidation of coking coal demand projections from a number of different sources appears in Table 4.

Table 4. ***Estimates of Canadian Coking Coal Demand***

1980	*1985*	*1990*	*1995*	*2000*
		(million tonnes)		
8.0	8.2–10.0	8.8–10.5	9.5–11.0	10.2–12.0

Other Demand

Excluding the utility and metallurgical industries, very little coal was consumed in Canada, only 1.9 million tonnes in 1979. Prospects for a significant increase in the industrial use of coal depend on the state of coal utilization and conversion technologies, relative energy prices, and further development of coal handling and distribution networks. Studies have identified possible industrial users, and it appears that only industries with relatively large energy requirements would likely find solid coal a suitable energy source.

Several industries have in the past used coal extensively, but relative energy prices and other considerations caused them to substitute oil and natural gas for coal. Now that coal is becoming economically attractive its use is being considered once again especially in plants that already have a coal-burning capability.

"New" industrial uses include using coal in conjunction with oil sands extraction and processing, and in the production of liquids for transportation fuels and for petrochemical feedstock. The factors related to the production of liquids from coal are discussed elsewhere in this paper. Medium-energy gas produced from coal is also likely to be needed for the production of some chemicals, especially methanol and ammonia. Processes of this kind can be an intermediate stage in certain coal liquefaction processes. Improved technologies may also be ready to produce high-energy gas from coal when needed in the Canadian economy (2010?). In surface facilities, the technology is likely to involve direct means of reacting steam with coal to produce methane; as applied to subsurface resources, underground coal gasification technology will likely be ready by that time to produce high-energy gas. The coal resources available for this purpose in Alberta alone are very large. Thus it becomes possible to support the natural gas expansion option for many years into the future with what is essentially a coal back-up. Because of the newness of the technologies it is difficult to accurately predict future demand for coal for these applications.

Indicative estimates of coal demand in the above-mentioned sectors are summarized in Table 5.

Table 5. ***Other Coal Demand***

Uses	*1980*	*1985*	*1990*	*1995*	*2000*
			(million tonnes)		
"Traditional"	2.0	4.0-6.0	4.0-7.0	4.0-7.5	4.5-8.0
"New"	—	2.5-3.5	6.5-7.0	8.0-10.0	12.0-15.5

Note: For "new" uses the bulk of the energy will be supplied from lower rank coals.

Demand for Coal in External Markets

In 1978, the last year for which complete figures are available, world coal trade reached approximately 200 million tonnes. Metallurgical coal dominated the trade, accounting for more than 92% of world coal movements. Only 8% of world trade is presently in thermal coal in spite of the fact that steam coal represents 80% of world coal production.

Canada exported about 900,000 tonnes of thermal coal in 1979 (of which approximately 70% originated in the west) and 13 million tonnes of metallurgical coal (almost entirely from western mines).

The future demand for Canadian exports of coking coal will be tied to steel production primarily in Japan but also in other nations. With respect to the demand for thermal coal, however, the situation is quite different. A rapidly growing international market in steam coal is developing in response to the world phenomenon of rising petroleum prices, planned diversification of energy

supplies on the part of oil importers and increased supply of competitively priced thermal coal.

A forecast of foreign demand for Canadian coal is presented in Table 6. This table is a compilation from several tables in the recent *World Coal Study* (1980). The metallurgical coal forecasts reflect price and infrastructure availability in Canada and elsewhere relative to future steel output, while the thermal forecasts reflect low and high growth scenarios for world oil prices and energy demand and the possibility of a nuclear moratorium.

Table 6. ***Forecast of Canadian Coal Exports***

	1985		*1990*		*2000*	
	Low	*High*	*Low*	*High*	*Low*	*High*
			(million TCE)			
Metallurgical	13	13	15	15	23	23
Thermal (Steam)	4	4	4–9	10–20	4–14	24–44

Source: *World Coal Study (WOCOL).* Ranges derived from Country Report for Canada. (Reprinted from Volume II of the WOCOL Report *Future Coal Prospects; Country and Regional Assessments.*)

Metallurgical Coal Exports

Table 6 forecasts that metallurgical coal exports by the year 2000 will reach 23 million TCE or a volume of approximately 25 million tonnes. This growth is based on forecasts of increased exports to all market areas to which Canada currently sells metallurgical coal: Asia, Western Europe and Latin America. In addition some new exports are forecast for Eastern Europe. The largest absolute growth in exports is predicted to occur in the Japanese market, which currently receives about 80% of Canada's metallurgical coal exports. South Korea, Western and Eastern Europe and Latin America are forecast to show large relative increases in the volumes of coal they will take from Canada, but because of the small amounts they currently buy, the total exported to these areas will remain small compared to the Japanese market. Exports to other markets may also show large relative increases as they look to Canada to supply some of the coal required to expand their iron and steel industries. If these forecasts prove accurate, Canada's metallurgical coal industry will double in size and mature through market diversification during the next two decades.

Thermal Coal Exports

Thermal coal exports may increase at even greater rates in the 1980s and 1990s than did metallurgical coal in the 1960s and 1970s. Thermal coal imports by Western European countries, Japan, South Korea and Hong Kong may increase more than four-fold in the coming decade. Canada is forecast to

become a major export supplier although, depending on assumptions about oil prices, energy growth rates and the possibility of a nuclear moratorium, the size of this market is not exactly known. While there is a great deal of uncertainty over the size of these exports in 1990 and 2000, there is less uncertainty over the likely destination of these exports. As with metallurgical coal exports, Japan will be the major purchaser of Canadian thermal coal. Other Asian markets, such as South Korea, Hong Kong and Taiwan, are also expected to purchase substantial volumes of Canadian thermal coal. It is anticipated that Pacific Rim nations may take up to 70% of all Canadian thermal coal exports in the next decade. Western Europe is the other region projected to import significant quantities of Canadian thermal coal. One long-term European thermal contract is already in place, and several other countries have expressed interest in evaluating the prospects of importing Canadian coal in the 1980s and 1990s. Another potential option is that of exporting thermal coal as an upgraded product such as electricity, and one such project is now under consideration. Thermal coal could also be exported in other upgraded forms.

Coal Transportation

Only 50% of the coal mined in Canada during 1979 was used at or near its point of origin. The rest, including the coal imported from the United States, had to be transported long distances from the mines to consumers. Transportation is therefore a vital and often expensive link in the coal system.

Prior to the 1960s coal was treated like any other commodity in the Canadian transportation medium; but during that decade the increasing number of large contracts for deliveries to Ontario and, at the end of the decade, the new large contracts for exports gave rise to dedicated coal transportation systems. A fleet of self-unloading vessels was built to carry millions of tonnes of coal annually across the Great Lakes, and integrated unit trains were introduced to carry coal 1100 km from the Rocky Mountain mines to new ports in Vancouver. In 1979 approximately 13 million tonnes of coal moved through Vancouver for export. In the mid- and late 1970s an additional unit train and coal terminal system was developed for the shipment of coal from the Rocky Mountains and Foothills to Thunder Bay for eventual delivery via Great Lakes freighters to southern Ontario.

Integrated unit train systems have been technically successful; however, they have run into higher operational costs than were originally expected. Partly as a consequence of these higher costs, rail tariffs have sometimes moved upwards out of sequence with coal prices. While average tariffs on coking coal exports declined relative to the FOB (free on board) minesite coal prices in the early 1970s, the opposite was true during the later years of this decade. The Canadian coal industry and others have for a number of years been concerned with the rate of increases in rail tariffs, and there is some apprehension that

continued unbalanced increases could adversely influence export and domestic sales of western Canadian coal.

In a few cases there are alternatives to rail haulage. For large quantities (greater than 10 million tonnes a year) and over long distances water slurry pipelines will be able to compete effectively. Oil slurry pipelines may ultimately be important in moving coal to the east or west. Conveyors and trucks are used for short hauls. Transport by water in barges or ships, some with self-unloading capability, is generally the most economical means of moving coal if a waterway is available. The federal government plays a part in transportation by water through the National Harbours Board.

Special problems arise in the transport of coal 200–300 km to the sites of oil sands–heavy oil plants. Water or oil slurry lines might be used for this purpose.

Transportation alternatives, however, are not restricted to carrying unmodified coal; it is quite possible to transport energy derived from coal as electricity or to transport liquid or gaseous fuels manufactured from coal. Coals of lower rank may be converted to an upgraded solid form to allow more economic transport by rail or pipeline.

The growth of exports during the 1970s and the forecast growth in the 1980s will put pressure on coal port and rail facilities in both western and eastern Canada. A proposal to substantially expand coal throughput capacity at the port of Roberts Bank near Vancouver was recently ratified by the British Columbia and federal governments, and dredging will begin in 1981. A new coal terminal will be required at Ridley Island near Prince Rupert some time in the 1980s as part of the coal development in northeast British Columbia. Rail lines will have to be constructed, upgraded and expanded to handle the increased coal movements forecast for many regions in western Canada. Upgrading of facilities at Sydney, Nova Scotia may also be needed.

Coal and the Environment

The single greatest environmental advantage of coal is that society has already experienced the industry at its worst. While there remains within society a certain uneasiness when it is confronted with the projected dramatic return to coal, it has been demonstrated that coal can be mined safely, transported easily and burned cleanly. The return to coal can be acceptable environmentally. Given the substantial increase in the world's coal consumption expected over the next two decades, there will be considerable emphasis placed on ensuring that every link of the coal chain will need to be as free as possible of health, safety and environmental side effects. The single most worrisome environmental feature of the prospect of increased use of fossil fuels, including coal, is the so-called green house effect of increased atmospheric CO_2 and its possible influence on world climate. The message for energy planners is: while there is

insufficient evidence in this area on which to base a decision to curtail the use of fossil fuels, there is some basis for seeking diversity in energy supply systems that do not produce CO_2.

The following is a summary of the environmental implications of the sequential links in the coal chain, from extraction and preparation to transportation, combustion and conversion.

Extraction

Mining of coal normally prevents the use of land for other purposes. Past surface mining practises have left virtually unusable landscapes, with serious surface and groundwater pollution, and chronic slumping and dust problems. However, modern mining practises incorporate land reclamation into the overall mining plan, often restoring the surface to a condition suitable to higher value use than would have been possible if left in its original state. When remedial or after-the-fact reclamation is insisted upon, the costs of reclamation generally become uneconomical.

The surface effects of underground mining are limited to spoil heaps, which can be smoothed and vegetated, acid mine drainage, which can be treated, and surface subsidence, which when a serious concern, results in a larger proportion (50%) of the coal being left in place. Occupational health and safety, however, are major concerns with underground coal mining. Safety precautions are now taken against gas explosions and flooding, which are the most serious causes of mine accidents, and dust levels are reduced through ventilation and filtration systems. While underground coal mining will never be a place for white gloves, technology exists to make it as safe as other heavy industrial activities.

Preparation

Fugitive dust is generated during the preparation of coal and thermal drying may produce pollutants similar in nature and greater in magnitude than thermal power plants (per quantity of fossil fuel burned).

Fossil fuel-fired, thermal driers discharging air and water pollutants are common for large metallurgical coal operations, and one large thermal coal producer uses a coal-fired thermal drier.

With the advent of strict sulphur emission regulations more thermal coal used in Canada may be required to undergo coal preparation and hence thermal drying.

Transportation

Coal is transported by train, truck, pipeline, or conveyor belt depending on distances. The principal environmental and safety consequences associated with increased movement of coal are dust (which can be controlled by

spraying coal cars with a latex coating), and increased road and rail traffic. Where water-coal slurries in pipelines are contemplated, there could be conflicts with other users of the water.

Combustion

The effects of coal combustion are perhaps more familiar to the public than any other link in the coal chain. A thermal station's tall stack, with its plume of smoke and the periodic taste of sulphur downwind from the station, provide the only tangible connections for most electrical consumers with coal. The discovery that the combustion products of coal, principally NO_x* and SO_2, convert into acid ions and fall to earth resulting in acidification of lakes, rivers and soils, adds a new dimension to the social and economic impacts of coal combustion.

The evidence is mounting that the acidity of rain has increased over the past two decades. Researchers point to the increased use of tall stacks during this period and the increased oxidizing capability of the atmosphere. It is argued that the tall stacks eject the precursors of acid ions high enough into the atmosphere such that they now have a much greater chance of being converted into acid-causing materials . Many of the offending taller stacks are associated with coal-fired plants in the eastern United States; thus, coal has earned for itself a certain amount of notoriety with those concerned about this problem. Coal combustion contributes nearly 50% of North America's total emissions of SO_2 and NO_x. Utility combustion contributes about 15% of the SO_2 emissions in eastern Canada.

Evidence indicates that acid deposition is responsible for substantial adverse effects on aquatic and possibly terrestrial ecosystems. Acid precipitation has also been shown to cause a reduction in certain crops, and to damage man-made and other materials such as metals, statuary and building stone. Acid loading causes normally immobile metals, including aluminium, lead and mercury, to move from rocks, soils and lake sediments into ground and surface waters resulting in further stress to fish populations and affecting sources from which household water supplies are drawn. Although the health effects of acid rain are not yet established, these toxic metals pose clear risks to human health as do airborne respirable acid particles and heavy metals.

The increase in carbon dioxide in the atmosphere is viewed with increasing concern by climatologists and agronomists around the world. It is known that CO_2 plays an important role in determining the temperature of the earth, particularly at northern latitudes, although it will be several years before this question is understood with any certainty. Although CO_2 containment from fossil fuel combustion has been under investigation for some time, no control technology seems feasible.

Other stack emissions from coal-fired thermal plants include hydrocarbons, carbon monoxide and a host of other substances emitted in lesser

* Oxides of nitrogen, predominantly NO, NO_2.

quantity such as heavy metals, polycyclic organic materials and radionuclides. With respect to the latter, the United States Government has just ruled such emissions as hazardous to health. Most coal thermal plants presently do not meet the radionuclide containment levels achieved by nuclear plants.

Most provinces enforce ambient air quality standards, frequently based on national air quality objectives. Some provinces have also adopted a permit system specifying maximum levels of various pollutants that may be emitted from a source. Additionally, some provinces and municipalities have set standards limiting the sulphur content of coal burned within their jurisdiction. As yet, there is no national containment or emission standard for thermal power plants. However, should all thermal generating units in Canada be required to meet, by 1990, the United States Standard for new sources (1.2 pounds of $SO_2/10^6$ Btu with mandatory 70–90% scrubbing), the additional annual revenue required for this level of pollution control and its impact on the cost of power generated across the entire grid would range from 0 to 15%. These costs are small when compared to possible fuel cost increases.

The technology exists to burn coal with more than 90% containment of emissions. Various types of "scrubbers" that remove SO_2 from flue gases are already in use around the world. These systems are most economical if employed on new plants. These scrubbing systems would be expensive for existing retrofit applications but may be justified on some major facilities. Some scrubbers produce large quantities of toxic sludge which can pose serious water quality, land use, and disposal problems. Converting existing oil-fired stations to coal may increase atmospheric pollutant emissions unless controls are installed. If flue-gas desulphurization proves impractical or too costly for certain applications then the following are alternate (although not necessarily as effective) control techniques. The use of coal-in-oil mixtures, coal-cleaning, switching to low-sulphur coal, and limestone injection systems are possible. On the horizon, there is fluidized-bed combustion which holds the promise of achieving environmental goals while enabling the burning of varying ranks of coal. Meanwhile, given the gradual trend to lower quality crudes, the residual oil which coal would replace would be relatively sulphurous.

Other impacts of coal combustion result from the leaching of toxic trace elements from solid waste piles, the thermal discharge to rivers or lakes supplying cooling water and the destruction of aquatic organisms drawn into cooling water intakes. Large amounts of water evaporated by some coal-fired power plants is also a concern where water resources are scarce. But these effects can be countered with the proper technology.

Conversion of Coal to Other Fuels

Coal conversion processes tend to leave major pollutants, such as ash and sulphur, in the ground or at the site of processing rather than where the energy in the coal is consumed. This can be an environmental advantage.

However, there are a number of health and environmental concerns associated with conversion facilities.

What risks that do exist for coal hydrogenation tend to be in the occupational area at conversion sites and would depend on the specific technology to be used. However, concerns common to existing pilot and operating facilities are known: for example, liquid fuels produced by direct liquefaction contain polycyclic organic materials (POM) as do the tarry and oily effluents of many liquefaction and gasification processes. During coal hydrogenation, hydrogen sulphide (H_2S), carbonyl sulphide (COS), and carbon disulphide (CS_2) are formed. Although these are later removed during sulphur recovery, workers could be exposed to them. The health effects of these substances are poorly understood but are believed to produce heart disease, disruption of menstrual cycles and growth inhibition. Careful monitoring systems will have to be installed at conversion facilities.

The emissions from metallurgical coke are covered by Canadian federal guidelines and the United States Environmental Protection Agency is considering listing coke emissions as hazardous air pollutants presumably due to the levels of hydrocarbon carcinogens emitted by the coke industry. Controls will be required.

In summary, while coal's past is environmentally reproachable, the technology and expertise exists to make its future as environmentally acceptable as the fuels that it will replace.

Technological Policy for the Canadian Coal System

Current annual expenditures on coal R&D by governments and industry in Canada of about $25 million and much larger expenditures by the senior coal producing nations (United States—$728 million in 1980, West Germany—$204 million in 1978, United Kingdom—$105 million in 1978) reflect the high costs of demonstrating the new coal technologies. It is clear that Canada must develop a clearly thought-out technological policy with respect to its coal needs. EMR is the lead agency for coal R&D in the federal government (federal expenditures on coal R&D—about $9 million in 1979-80) and has traditionally shown leadership in this field almost since its inception. But the combined expenditures of the provinces* may soon exceed those of the entire federal government.

While the main part of the coal R&D effort of interest to Canada will be conducted outside the country, there are several fields of activity that can be considered virtually unique to Canada. Examples include: optimum use of coal in the extraction and upgrading of the oil sands–heavy oils of Alberta and Saskatchewan; development of underground mining technology applicable to

* In the case of Alberta about $30 million of the original $96 million endowment of federal funds used to create the Alberta-Canada Energy Resources Research Fund has been notionally dedicated to coal.

the Cordilleran region of Alberta and British Columbia; and the possible development of coal in oil slurry pipeline technology.

The responsibility lies with the various governments not only to identify such unique opportunities and problems but also to recommend how possible solutions may be evaluated and demonstrated in the Canadian context.

A comprehensive understanding of the significance of foreign developments to Canadian coal characteristics, costs, market opportunities, etc. must be developed and maintained in order to facilitate Canadian access to these developments on at least acceptable terms in an era when nearly all demonstration activities are at least partly funded by governments (mainly because costs and technical risks are extremely high).

While it is not possible to say with any certainty who the main participants in the coal conversion field will be, questions of maintaining an adequate level of Canadian ownership will almost certainly arise. There is also the related question of the supply of professional, technical and skilled staff for this industry.

Governments must have a clear idea of how to utilize the nation's vast coal deposits for the benefit of the provinces as well as for the country as a whole. Specific demands on these resources may include a much increased transportation of coal to central Canada in the unlikely event of a nuclear slowdown or moratorium.

In short, Canada should have a technological policy for coal, and those devising that policy need access to laboratory R&D operations to follow this fast developing field. The Canadian public must also be assured that coal can be produced, transported and utilized safely.

Tables 7 and 8 summarize the "state" of coal technology. Table 7 lists the main technological improvements of interest to the provinces and Table 8 indicates the most likely time frame of some of these technological achievements.

Table 7. ***Technological Improvements Complementing Expanding Coal Production and Utilization***

British Columbia

- Underground mining methods
- Beneficiation processes
- Transportation (coal slurry pipelines, solids conveying techniques)
- Most appropriate production techniques re: coking process and coal-based reduction process for small-scale steel mills
- Coal liquefaction
- Conversion of large industrial energy users to coal, e.g. cement plants

- Environmental protection

Alberta

- Underground mining methods, underground extraction methods, i.e. coal gasification in situ including techniques for production of hydrogen
- Pipeline and other transportation technologies
- Methods for the gasification and liquefaction of sub-bituminous coals including techniques for the production of methanol and ammonia
- Methods of using coal in the context of oil sands–heavy oil industry and for producing CO_2 for enhanced oil recovery
- Environmental protection re: reclamation and combustion for electrical generation

Saskatchewan

- Underground coal gasification techniques
- Coal (lignite) slurry pipeline processes
- Lignite "up-grading" process, including "charring" processes, to allow economic and safe shipment to distant markets
- Utilization of coal in heavy oil industry, lignite-using iron reduction process, production of medium-energy gas for potash industry, development of advanced coal-to-electricity process (which combines containment of sulphur with lower capital cost and higher conversion efficiency)
- Coal liquefaction

Manitoba, Ontario and Quebec

- Techniques for transporting and using surface-mined coals in Ontario
- Advanced coal-to-electricity processes to contain CO_2 and NO_x, development of medium-scale fluidized-bed combustion technology for industrial use, coking and iron reduction processes

New Brunswick

- Means of reducing sulphur content of the coal
- Coal-oil mixtures, fluidized-bed combustion

Nova Scotia

- Underground mining methods applicable to undersea resource extraction
- Beneficiation methods for sulphur removal
- Coal utilization techniques, e.g. atmospheric fluidized-bed combustion, carbonization processes to permit production of high quality coke minimizing low-volatile coal inputs, small scale carbonization processes, new iron-making

techniques that would permit production of synthesis gas as a by-product, refinery use of coal (and biomass) for motor fuel production, processes that would make coal use attractive for smaller industrial users and for district heating purposes

Table 8. ***The Coal Utilization Technology Calendar***

Technology Available In

1980

- Fluidized-bed combustion at atmospheric pressure for industry and smaller utility applications
- Coal-in-oil combustion
- "SASOL" (South African Coal, Oil and Gas Corporation) coal liquefaction technology
- Coal-to-methanol
- Coal for steam-raising in oil sands exploitation

1990

- Pressurized fluidized-bed combustion and combined-cycle coal-to-electricity processes for large scale utility applications
- United States coal liquefaction processes presently being demonstrated ("Exxon", "Gulf", "H-Coal"); West German, British, and Japanese processes also becoming available
- Integral use of coal in the oil sands-heavy oils industry, for example, the development of coal plus bitumen co-processing techniques

2000

- Improved generation processes to make SNG (substitute natural gas)
- Improved underground coal gasification processes
- Advanced coal liquefaction processes

International Coal Considerations

The Emerging Energy Coal Market

During the 1960s, the world demand for thermal coal dropped off dramatically. Not only was oil used as the source of energy in most new thermal plants, but also it replaced coal in many existing ones.

All of this changed in 1973. Rapidly increasing oil prices, realization that reserves were declining in many parts of the world, and uncertainty as to the availability of much of the remaining supplies caused many importing

countries to review their future patterns of energy consumption. More efficient utilization and development of renewable energy sources were seen to be important measures to lessen the dependence on oil. More important, particularly in the short term, was the substitution for other proven sources of energy. Of these, coal was best known and most abundant.

By now, most major energy importing countries have developed strategies intended to lessen as quickly as possible their dependence on imported oil. For most, energy coal plays a key role. For example, Japan imported less than 1 million tonnes of thermal coal in 1977 and is projected to increase this to as much as 50 million by 1990. In spite of several substantial indigenous deposits, Western European countries are also looking to imported coal to meet a growing proportion of their energy requirements. Taiwan and South Korea and a number of other rapidly industrializing countries can be added to this list.

Coal supply policies of the principal importing countries are generally similar. The importance of developing several long-term, secure sources of energy coal is being given increasing priority, although price continues, of course, to play an important role. Investment in the productive facilities, including infrastructure and co-operation in technology, are supporting measures intended to tie the exporting country more securely to its customer. Because of the importance attached by other governments to securing their countries' sources of energy, they are becoming increasingly involved in energy transactions, either directly or through state-owned or controlled companies.

Up to now an overwhelming proportion of Canadian metallurgical coal production has been exported and despite recent efforts to diversify markets, Japan has dominated internationally. With the emergence of an international market for coal as an energy commodity, the circumstances will be different. There will be several suppliers and even more buyers. No one producer or consumer need dominate this new market. Although Canada will not be among the largest suppliers because the present indications are that Canadian costs will be higher than those of three or four other major supplier nations—Australia, South Africa, United States—our presence or absence will influence the evolution and operation of this market. Few, if any, countries export a higher fraction of its coal production than Canada, and this nation is amongst the very few major coal producers with the potential to supply new and expanding coal markets. Open and avowed participation by Canada will therefore be important in making the new international market less "administered" and more independent of the controlled international price of oil. (Some of the implications of this burgeoning growth in the world's energy coal market have already been dealt with in the section "Demand For Coal In External Markets.")

The maturing of the international market for energy coal will yield a new international energy reference price. This new international coal "marker" price should take its place alongside two existing world-wide reference prices—

the OPEC (Organization of Petroleum Exporting Countries) controlled world oil price and the cost of electricity from new nuclear installations, which in principle should be essentially independent of location. Energy policies will need to take this new thermal coal reference price into account. In the Canadian case, for example, the world energy coal price could provide a measure to assess the advisability of proceeding with specific utilization options.

Canada is presently pursuing a relatively "open" or "free floating" coal option. Coal and coke enter and leave Canada freely now. One policy stance might be to continue this position in spite of the fact that other important energy supply options (oil, natural gas, nuclear) are gravitating towards more rigorously controlled regimes. A free international market approach towards thermal coal can yield benefits both in terms of energy balances, particularly for eastern Canada, and internationally through the additional flexibility and robustness this development will confer upon the world energy system. We may be able to sell thermal coal produced in British Columbia or Alberta to Korea and import Polish coal to Saint John; by so doing we are really transferring coal from western Canada to eastern Canada without incurring the high transportation costs applying to direct shipment. We have long used "swaps" in the oil industry to our advantage, and there appears to be no reason that we should not do so in the coal industry as well. Provided an international market exists, it may be assumed that we can participate in these transactions on even terms. We also bring into use another major asset—the availability of deep water ports on both coasts capable of loading and unloading ships of efficient sizes. In contrast to large oil tankers, the environmental risks associated in this shipping are minimal. We can then choose, if we wish, to exercise major coal utilizations options in eastern Canada—notably the generation of electrical energy—without being constrained by local coal supply.

International Coal Relations

One result of the international energy discussions concerning the 1973 oil crisis has been the promulgation of international coal relations. A number of Canada's trading partners, confronted with the necessity to substitute coal for oil have sought, through collective means, to assure ready and dependable access to internationally traded coal.

A set of principles for IEA (International Energy Agency) action on coal and a procedure for reviewing member countries' coal policies was adopted in May 1979.

Based on the recognition that it is desirable to exploit the world's abundant coal resources to meet growing energy demand in the medium and long term, the principles provide for enlarged coal use, primarily through minimizing the use of oil in electricity generation and encouraging the construction of new coal-fired power plants.

In support of this objective, the IEA has summarized the common principles:

- Reduce uncertainty about national coal policies;
- Formulate appropriate energy pricing policies that will allow coal to develop its full competitive power;
- Encourage a suitable climate that would stimulate capital investments on a scale commensurate with coal's long-term potential (including the development of transportation systems, port facilities and other supporting infrastructure);
- Grant high priority status to research, development and the rapid commercialization of advanced coal technology;
- Encourage co-operative efforts to facilitate the expansion of international trade in coal on a basis that encourages the development of stable relations between consumers and producers, on fair, reasonable and competitive terms; and
- Monitor progress in the development of national coal policies. Member countries will be prepared to consult with one another (under the aegis of the IEA Governing Board) about major elements of their respective coal policies and their trade or investment policies related to coal.

While the principles are designed to achieve increased coal production, trade and utilization on the basis of international co-operation, it is recognized that the contribution on the part of member countries will be subject to their particular domestic energy circumstances, social and economic requirements including environmental considerations, constitutional structures and national economic systems.

One year after the adoption of the original Principles for IEA Action on Coal, the Federal Minister of Energy, Mines and Resources, the Honourable Marc Lalonde, reiterated at a Governing Board meeting of the IEA, the Canadian Government's adherence to this common international position on coal. This was the second instance of public support for the plan, the first being the Tokyo Summit held in the summer of 1979. More recently, at the Venice Summit, the western industrialized nations called for a doubling of their coal production and use by 1990.

The Liquefaction Option—A Special Case

Directly related to international considerations is the special case of coal liquefaction. Canada, like most other developed countries, is short of liquid fuels for use in the transportation industry. These liquids can be produced from coal in a number of ways. But there is a further aspect of this emerging technology that is of special interest to Canada; the liquids produced can in many cases be moved by pipeline and thus the transportation problem that

inhibits the use of coal in Canada more than in any other nation, except perhaps for the U.S.S.R., can also be overcome.

The coal liquefaction option for Canada will be determined by international and domestic developments in the field of synthetic liquid fuels production technologies. These choices are:

- Processes such as the one used in South Africa (SASOL) could be built now, but the estimated cost (1980) of the synthetic oil is considerably higher than the comparable price of imported oil.
- Canada may wish to wait until the end of the 1980s when processes being developed in the United States, West Germany, the United Kingdom, Japan and perhaps elsewhere are expected to become available for the routine production of a liquid product compatible with the present need of the transportation industry at a cost comparable to that from imported oil. Suitable coal can be obtained from a number of sites in western Canada at attractive prices. Moreover, it is possible there could be other advantages accruing to conversion plants erected at the best Canadian sites not available to those in other coal producing countries; for example, natural gas might be used to advantage in some processes, particularly in the early years, because of the process simplification possible, or by-products such as carbon dioxide may find markets in Canada for use in the enhanced recovery of oil. Another advantage that might result in economies of liquid fuel production for transport arises because high octane gasoline can be produced in some coal liquefaction processes while processing oil sands bitumen is better suited to the production of diesel fuel. The advantage associated with the best Canadian sites is likely to be large enough to attract development proposals from oil deficient nations such as West Germany and Japan. Already some preliminary feelers have been extended. In the long run, the costs of coal-derived fuels should place a "cap" on the international price of oil because the world's coal resources are sufficiently large to sustain a major production of synthetic transportation fuels. In the United States for example, the recently established Synthetic Fuels Corporation has been allocated $20 billion to facilitate the production of 500 Mb/d (thousand barrels a day) of synthetic liquids from all sources by 1987. The Corporation has the option to proceed to a level of production of 2 MMb/d (million barrels a day) at a further cost of $68 billion by 1992.
- Coal could be converted to methanol now at a competitive cost; however, it would be necessary to develop the appropriate technology for utilizing this fuel (conversion of methanol to gasoline, new engine development, introduction of gasoline-alcohol mixtures, etc.). A promising new process may become available for the conversion of methanol to a gasoline compatible product. These issues are discussed in detail in a companion paper on liquid fuels.

- Canada may choose not to liquefy coal and instead opt for the accelerated development of oil sands and heavy oil projects which would produce liquid fuels at a cost below (at least not more than) that of imported oil and coal-derived fuels. Coal could still be used extensively in these processes as a source of energy needed for steam raising and as an external source of hydrogen. The rationale for using coal in the oil sands–heavy oils industry is to lower the cost of the synthetic fuels produced and to increase the quantity available.

Canada's interests may best be served by pursuing the second option listed above. This might be done in a limited way even though it may be more costly than the oil sands because it may not be possible to extract all of the oil needed from the oil sands fast enough to meet potential gaps in the supply of transportation fuels, and it may be desirable to develop alternate sources of liquid fuels in other provinces. But it may be best to develop the expensive facilities needed (perhaps $5 billion investment for a 50 Mb/d plant), using, if not novel, pioneering technology in partnership with other nation(s). In the event that we do not in fact require the additional and more expensive fuel, the surplus could be exported to the partner(s) at the international price of oil (an economic rent may be collectable).

Other Industrial Benefits

Backward linkages is the term used to describe the employment and income generated by the demand for factor inputs by a "primary" project. In the case of Canadian coal, these projects would include coal mining, processing, transportation and utilization.

In other mining developments these "secondary" benefits can be as large or larger than the original project itself. Therefore, one might expect a somewhat similar situation for coal where the fulfillment of backward linkages within the country would serve to greatly enhance the overall contribution of the resources to the national economy.

Aside from these stimulative implications, creating (or maintaining) a national capability to supply certain factor inputs may also serve to reduce some of the bottlenecks facing coal developers and users. For example, the world-wide shift to thermal coal will undoubtedly constrain the ability of traditional suppliers of major equipment items (draglines, etc.) to meet increased demand. Canadian customers may find their projects delayed because of long waiting periods for inputs. Therefore, aside from optimizing employment and value added in Canada, security of supply to producers (within a reasonable time frame) would also be a consideration in support of encouraging backward linkages in Canada. In some cases Canadian suppliers to the coal industry will displace imported goods and services adding not only to the balance of trade but also to the degree of price competition in coal equipment and other related markets.

Distribution questions are also important. While coal producing provinces have taken the position that backward linkages should be fulfilled within a particular province there is some economic justification (i.e. economies of scale, proximity to certain inputs such as steel, etc.) for producing goods elsewhere within the country. Major coal users (i.e. utilities) have not taken a similar stance regarding backward linkages. In summary, there exists a potential to spread the "secondary" benefits associated with coal to regions that are not themselves endowed with the resource.

REGIONAL CONSIDERATIONS

Introduction

This section deals with the Canadian coal system in each of the major provinces that are interested in coal as either producers or consumers. The object here is to illuminate the Canada coal system from the viewpoint of each of the main regions that is interested in pursuing an active, increased coal option as part of their energy, industrial or regional development strategies.

British Columbia

Although coal deposits in the province are widely distributed, only one region, the southeast or the Crowsnest Pass coalfield, is being commercially exploited. British Columbia is second only to Alberta in its resource endowment with 52.8% of the nation's measured lignite resources and 47.7% of measured low- and medium-volatile bituminous resources. The quality of the province's resources are of particular interest in that they are suitable for thermal, metallurgical and coal conversion applications.

In June of 1977, British Columbia became the second province (after Alberta) to release a coal policy. The policy is embodied in 11 policy statements that were put forward "to clarify for the industry and the public the basis upon which current and future development of the coal resource (of British Columbia) will be undertaken." Key points of the policy included: (1) commitment to the development of coal resources in a manner consistent with overall provincial energy, economic, environmental, regional development and social objectives; (2) commitment to the concept of meeting provincial coal needs first, followed by requirements of other provinces and finally export demand; (3) commitment to the use of provincial expertise and resources in coal developments; (4) commitment to development of multi-resource communities rather than single-resource or company communities; (5) support and encouragement for research and development programs and manpower-planning activities; (6) commitment to the philosophy that the coal industry be taxed at a rate similar to that applied to other industries; (7) retention of the existing $1.48 a tonne royalty on coking coal (subsequently modified to 3.5% of the minehead value of the coal); (8) commitment to the philosophy that coal sold outside the province must be marketed at competitive world prices; and (9) commitment to the support and encouragement of programs related to initiation of alternative end uses and further processing of coal in the province.

In 1979 British Columbia produced over 10 million tonnes of saleable coal. Over 90% of this was coking coal exported to Japanese and other foreign markets, with the remaining 10% sold to domestic thermal and industrial markets. About 2% of their total production is used within the province.

One very large low rank coal deposit occurs at Hat Creek, about 330 km (by air) from the west coast (about 450 km by land). At present, this coal is being considered for use in electricity production within the province, although liquefaction is also a possibility. However, other deposits of this magnitude may yet be found and should coals from such sources prove to be available for export applications, joint studies will be required with potential consumer nations to devise mutually acceptable means for their exploitation and utilization.

The advantages inherent in the British Columbia coal situation that might be set out are:

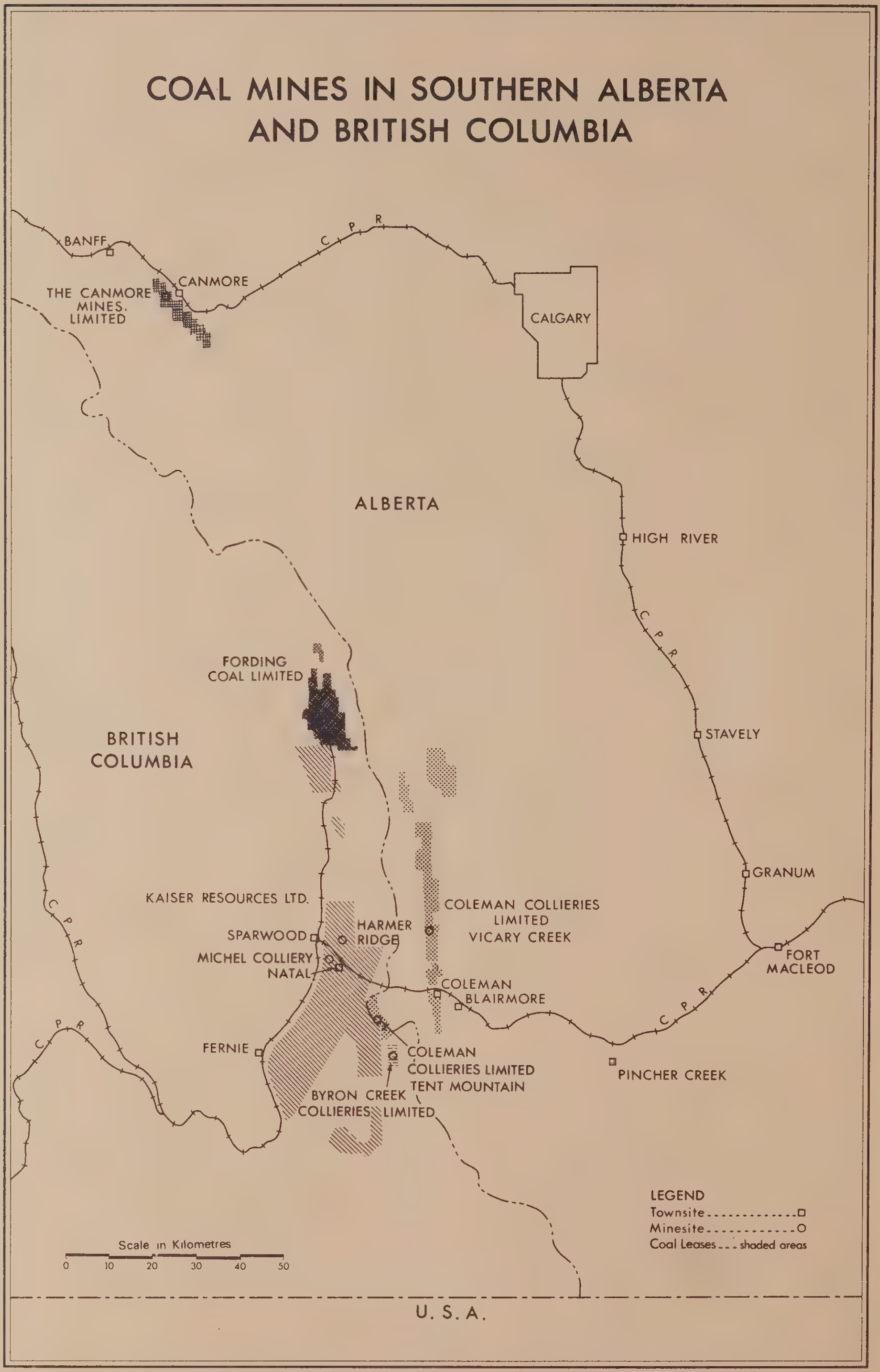
- A large resource base could support substantial expansion of the industry.
- The proximity of the large Hat Creek coal deposit to the west coast.
- Coal can provide "base load" to justify railway improvements, which should assist all goods carried.
- Coal can be used to "back-up" some wood-using facilities now being installed by the forest industry to save oil.

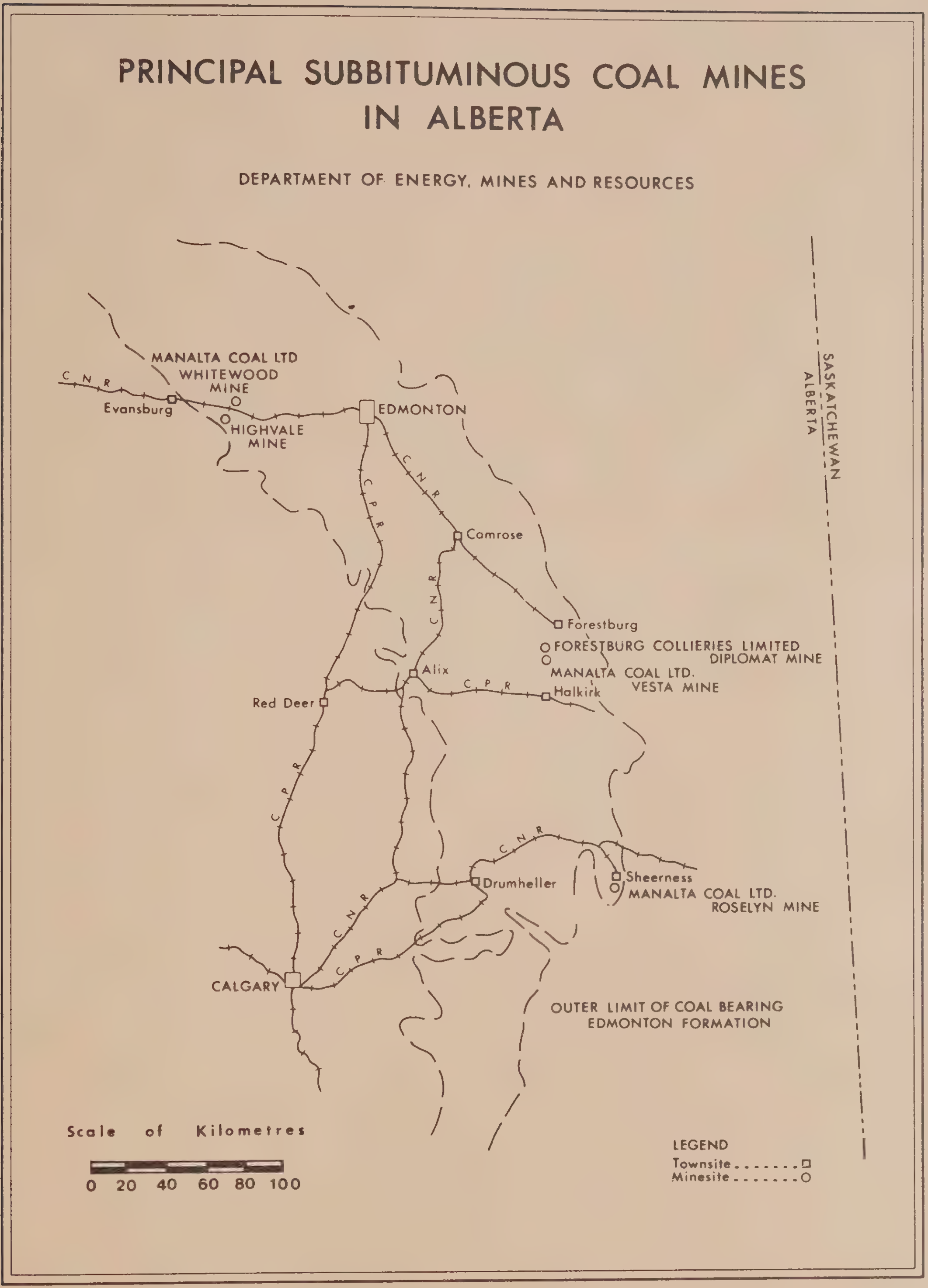
The industrial development options for British Columbia related to coal include:

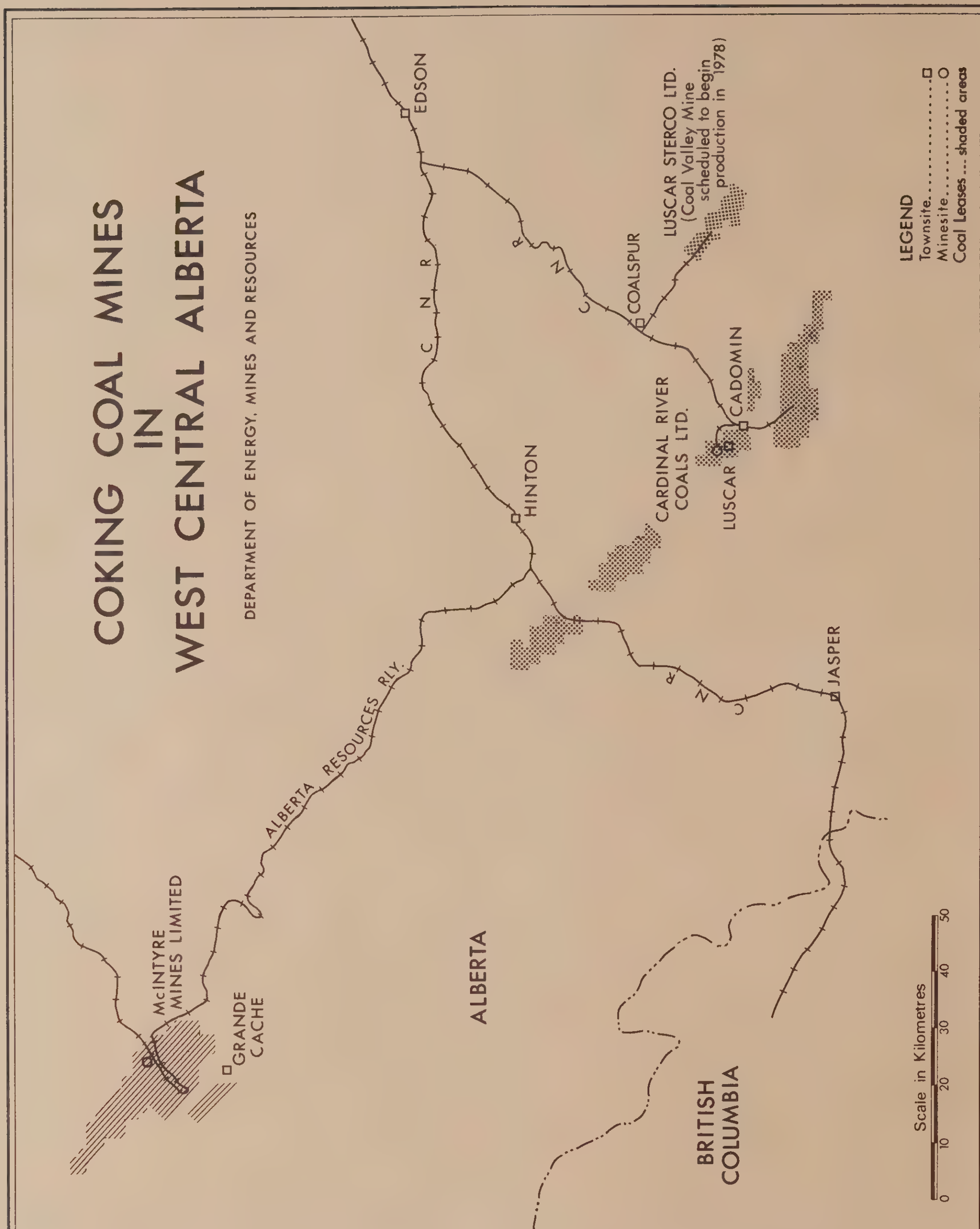
- Building of a local primary steel industry, either of the conventional type with blast furnace in co-operation with consuming nations, such as Japan, or smaller facilities based upon direct reduction processes;
- Expanding of aluminum industry based on electricity generated from coal; possible extraction of alumina from Hat Creek coal ash;
- Re-building existing antiquated coking facilities to expand export of coke, possibly including the foundry grades; by-product gas may be useful for local industrial purposes; and
- Installing liquids-from-coal and advanced electricity-from-coal facilities can also result in major local industrial spin-offs.

Alberta

Alberta's producing mines are situated in three geographical regions within the provinces—the Mountain, Foothills and Plains. Resources of the Mountain region are primarily of the low- and medium-volatile bituminous rank and total 8,000 million tonnes or 52.3% of the national total of this rank. Foothills coal is high volatile bituminous and, with 1,300 million tonnes of measured resources, accounts for about 85% of Canada's total stock of coal of this rank. Lastly, the Plains region contains 30,000 million tonnes of sub-bituminous coal, essentially all of the domestic resources of this rank. In total, Alberta's coal resources are the most extensive in the country.


COAL MINES IN SOUTHERN ALBERTA AND BRITISH COLUMBIA
BANFF
C P R
CANMORE
THE CANMORE MINES, LIMITED
CALGARY
ALBERTA
HIGH RIVER
FORDING COAL LIMITED
BRITISH COLUMBIA
STAVELY
GRANUM
KAISER RESOURCES LTD.
HARMER RIDGE
SPARWOOD
MICHEL COLLIERY
NATAL
COLEMAN COLLIERIES LIMITED VICARY CREEK
COLEMAN
BLAIRMORE
FORT MACLEOD
FERNIE
COLEMAN COLLIERIES LIMITED TENT MOUNTAIN
PINCHER CREEK
BYRON CREEK COLLIERIES LIMITED
LEGEND
Townsite
Minesite
Coal Leases - - - shaded areas
Scale in Kilometres
0 10 20 30 40 50
U. S. A.


PRINCIPAL SUBBITUMINOUS COAL MINES
IN ALBERTA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
MANALTA COAL LTD
WHITEWOOD
MINE
C N R
Evansburg
EDMONTON
HIGHVALE
MINE
C N R
C P R
Camrose
C N R
Forestburg
FORESTBURG COLLIERIES LIMITED
DIPLOMAT MINE
MANALTA COAL LTD.
VESTA MINE
Alix
C P R
Halkirk
Red Deer
C P R
C N R
Drumheller
Sheerness
MANALTA COAL LTD.
ROSELYN MINE
C N R
C P R
CALGARY
OUTER LIMIT OF COAL BEARING
EDMONTON FORMATION
SASKATCHEWAN
ALBERTA
Scale of Kilometres
0 20 40 60 80 100
LEGEND
Townsite
Minesite


COKING COAL MINES
IN
WEST CENTRAL ALBERTA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
EDSON
C N R
LUSCAR STERCO LTD.
(Coal Valley Mine
scheduled to begin
production in 1978)
COALSPUR
CADOMIN
CARDINAL RIVER
COALS LTD.
LUSCAR
HINTON
ALBERTA RESOURCES RLY.
JASPER
McINTYRE
MINES LIMITED
GRANDE
CACHE
ALBERTA
BRITISH
COLUMBIA
LEGEND
Townsite
Minesite
Coal Leases ... shaded areas
Scale in Kilometres
0 10 20 30 40 50

Alberta's coal policy was documented in the June 1976 statement "A Coal Development Policy for Alberta." The policy was designed "to bring and maintain the maximum benefits, now and in the future, to the people of Alberta." Exploration and development of the coal resources of the province were to be encouraged when compatible with the environment, as well as economic and labour conditions in the province. New coal developments, which satisfy environmental regulations, were to be developed first to meet Alberta's own electric energy and industrial requirements and then to serve other Canadian and foreign markets, provided such demands could be satisfied while protecting Alberta's present and future requirements. Coal developments were required to make the maximum use of provincial manpower, services, materials and labour, and to encourage equity ownership by provincial residents. A new provincial royalty formula based on costs of production, gross revenue and cumulative investment replaced the old 11¢ a tonne royalty. The province was divided into land classification regions by which all future coal-related activities were to be evaluated. The regulation of exploration and development varied from the prohibition of activities in some areas of the Foothills region; to limited access and development in others; to relatively few restrictions in those areas of least environmental and social conflict.

Alberta is currently Canada's leading coal producing province. Production of saleable coal in 1979 reached 15 million tonnes. Provincial consumption of thermal coal exceeded 9 million tonnes. Over 1.5 million tonnes of coal was marketed to other Canadian provinces, while nearly 4 million tonnes was sold to foreign customers.

There are a number of advantages associated with coal in Alberta:

- Large resources of surface-mineable sub-bituminous coal of low sulphur content exist, which can be mined at attractive costs with known technology. This coal is the basis for expanding the coal-to-electricity option of the province, which is presently meeting high growth rates in demand. (In 1979, the province's largest utility reported a gain in energy sales of 11.2% over 1978, while electricity demand for the province as a whole is growing currently at a rate of 8% a year.) This coal supply could also be the basis for a family of new uses within the province—for applications in the oil sands-heavy oils industry, ammonia and methanol production, medium-energy gas production, a variety of industrial uses, etc. The development of an economic process to upgrade the energy content of these coals, coupled with more effective transportation methods, would allow their use in distant Canadian or export markets.
- Large resources of higher energy content coals in the Foothills and Mountains regions allow their export with present mining and transportation technologies.

Industrial development options for Alberta related to coal include:

- Availability of metallurgical coals would be a favourable factor in the development of a local steel industry along conventional coke ovens–blast furnace lines.
- Surface-mined coal costs are low enough to justify industrial developments based on the use of coal for example, aluminum production.
- Production of fertilizers and certain chemicals and chemical intermediates could be based upon coal.

Saskatchewan

Only one rank of coal—lignite—is produced in Saskatchewan. This coal is of low energy content (typically 16 megajoules/kilogram), and is therefore relatively expensive to transport. This class of coal can only be used in specially designed facilities. Saskatchewan uses more coal in its primary energy balance than any other province (about 21%); almost all of this coal is used for electrical generation.

The Saskatchewan coal policy emphasized the critical role that coal can play in meeting future provincial energy needs and was announced after completion of several coal studies. The policy consists of elements meeting five basic objectives: security of energy supply, economic benefits, environmental protection, social benefits, and research and development. The policy prescribed administrative procedures for licensing new coal mines and for depositing of Crown coal rights, levied a new royalty of 15% of the minehead value of coal and introduced a property tax on freehold coal rights. The Government emphasized the dynamic nature of policy development and noted that future circumstances could necessitate amendments to this policy.

Production of lignitic coal during 1979 remained stationary at 5 million tonnes in Saskatchewan. Over 90% of its production is consumed at provincial utility facilities for the generation of electricity. Approximately 300,000 tonnes of coal is marketed in other provinces, primarily Manitoba and Ontario. Some "char" is produced and used for a variety of reasons, including the manufacture of barbecue briquettes.

The advantages of coal in Saskatchewan are:

- Use of lignite in the present coal-generating electrical stations represents a reasonably low cost route to electricity.
- Coal-derived electricity is being used as a basis for further expansion in the potash and steel industries of the province.
- Coal could be a source of heat and hydrogen for the heavy oil extraction and up-grading industry of the province.
- Production of methanol and other coal liquids would represent a major development within the province.

Manitoba, Ontario and Quebec

While some coal deposits occur in the southwestern region of Manitoba and consideration is presently being given to mining the low-rank lignite deposit that occurs near Onakawana in northern Ontario, no coal is being mined in these provinces. The coal resources of Quebec are negligible.

In spite of this, Ontario is a major consumer of coal (see Table 3), the bulk of which has been bituminous coal from eastern United States mines. This pattern is beginning to change as the province is receiving coal from western Canadian sources along an up-graded transportation network. In 1979, the first full operating year of this system, over 2 million tonnes of coal were moved from the west to Ontario markets. This represents approximately 20% of Ontario's thermal coal supply.

However, the extent of the future use of coal in these three provinces remains uncertain because of:

- Delivered cost of coal to the industrial sector relative to oil and natural gas;

- Problems of receiving and storage infrastructure;
- Cost of coal-derived electricity relative to nuclear and hydro;
- Issue of environmental acceptability; and
- Question as to the future supply from the United States.

New Brunswick

New Brunswick possesses only limited resources that are restricted to coals of one rank (high-volatile bituminous) containing very high quantities of sulphur (5–8%). A single seam, of about 0.50 metres thick, is being mined.

Production in 1979 exceeded 300,000 tonnes, the majority of which was marketed to the provincial utility for the generation of electricity. Approximately one-third of all output is sold as industrial coal to Quebec consumers. Overall production is expected to nearly double in the early 1980s as a new mine in the Salmon River area comes into production.

Coal utilization in New Brunswick will be influenced by several factors including the continued competitiveness of its resources by the nearness of the Cape Breton industry and relatively low shipping costs to deliver coal to New Brunswick's shores. The deep harbour sites in the Bay of Fundy suggest that coal could be imported on favourable terms from abroad in large ships and from western Canada via Vancouver and the Panama Canal. Coal from the United States could also be imported, but the relatively short distances involved would not justify using large ships.

It is important to decrease the dependence on imported oil for electrical production in New Brunswick and expanded coal fired electrical generation is an important future option. In support of this alternative the New Brunswick Electric Power Commission has been granted exclusive access to the province's proven and indicated coal reserves.

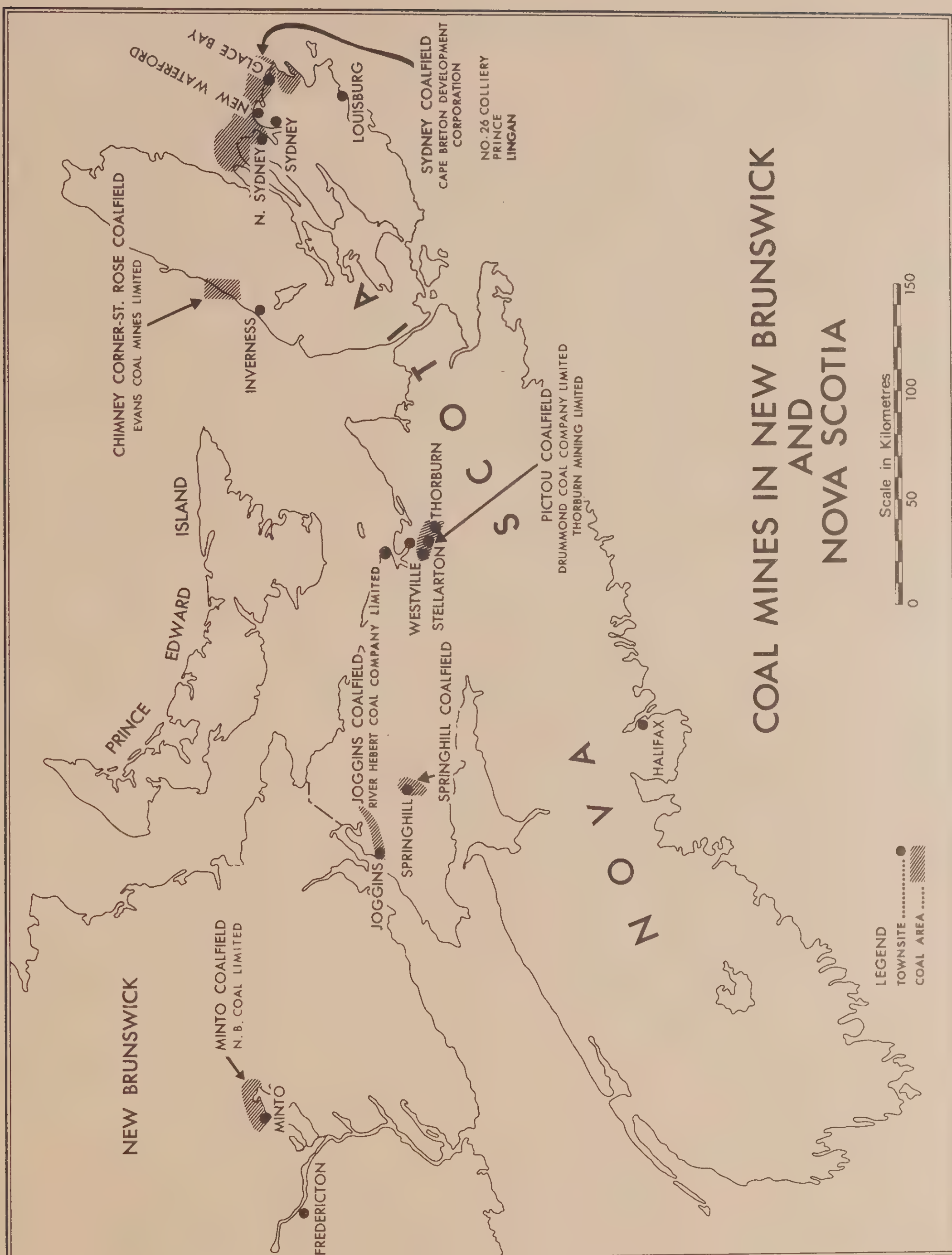
The two main problems associated with an increased use of coal are:

- How best to use an acceptably priced but severely limited local supply of high sulphur coal effectively and safely.
- How best to use an international coal supply option to supply energy both for utilities and industry in the province.

There appears to be no significant industrial development option based upon the indigenous coal supply. However, a supply of coal at prices set by the emerging international market could be available to the forest and non-ferrous smelting industries and to other industrial users.

Nova Scotia

The major coal resource in the Atlantic provinces lies off the shore of Cape Breton. Three mines—Lingan, No. 26, and Prince—are operated by


COAL MINES IN NEW BRUNSWICK
AND
NOVA SCOTIA
NEW BRUNSWICK
PRINCE EDWARD ISLAND
NOVA SCOTIA
MINTO COALFIELD
N. B. COAL LIMITED
MINTO
FREDERICTON
JOGGINS COALFIELD
RIVER HEBERT COAL COMPANY LIMITED
JOGGINS
SPRINGHILL
SPRINGHILL COALFIELD
WESTVILLE
STELLARTON
THORBURN
PICTOU COALFIELD
DRUMMOND COAL COMPANY LIMITED
THORBURN MINING LIMITED
HALIFAX
INVERNESS
CHIMNEY CORNER-ST. ROSE COALFIELD
EVANS COAL MINES LIMITED
N. SYDNEY
SYDNEY
NEW WATERFORD
GLACE BAY
LOUISBURG
SYDNEY COALFIELD
CAPE BRETON DEVELOPMENT CORPORATION
NO. 26 COLLIERY
PRINCE
LINGAN
Scale in Kilometres
0
50
100
150
LEGEND
TOWNSITE
COAL AREA

DEVCO. With current technology, the only access to the seams is from the shore. Thus coal availability is limited in a fundamental sense in that mines must gradually reach further and further out under the sea as the resources are exploited.

Coal production in Nova Scotia exceeded 2 million tonnes in 1979. Approximately 650,000 tonnes of this coal was marketed within Nova Scotia for thermal purposes and more than 500,000 tonnes for coking purposes. In addition, approximately 600,000 tonnes were sold to other Canadian provinces and 500,000 tonnes to overseas markets.

Nova Scotia's coal development policy was revealed as part of the $1.2 billion energy initiative announced by the Premier in the fall of 1979. While the program is primarily designed to eliminate the province's excessive dependence on imported oil by 1990, regional economic growth objectives, especially through coal developments, is an inherent feature of the strategy.

The substitution of oil for coal in electrical power generation is seen as a means of achieving both objectives. According to the plan, thermal coal production would increase from the current level of 1.6 million tonnes to over 5 million tonnes by 1990; while coking coal production would also rise substantially. An increase in output of this magnitude would require the development of new mines on Cape Breton Island.

RD&D (research, development and demonstration) projects in the package include the evaluation of a 150 MW(e) (megawatts, electric) fluidized-bed combustion unit most likely to be located in Cape Breton and a facility to produce coal in oil slurries useful in a number of industrial-commercial applications. Other coal-related projects include a coal-blending plant to provide a consistent quality feed for electrical generation, a coal testing facility, a study of pollution control technologies, and a system for monitoring developments in alternative coal uses. Substantial federal involvement is anticipated in these projects.

The advantages of coal production and utilization in Nova Scotia are:

- A significant deposit occurs at the sea coast, which at present prices may be worked economically.
- An experienced workforce exists with long experience in underground mining.
- Markets in Canada and abroad exist for coal products, especially coke.
- Coal may be a useful back-up for a biomass liquid fuels option; other special coal liquefaction options may be applicable in the region.
- An operating integrated steel mill is located near the coal fields.
- Deep water port sites allow the possibility of exporting or importing coal economically.

CANADIAN COAL OPTIONS

The magnitude, direction and pace at which Canadian coal can penetrate domestic and international energy markets will depend upon how governments, industry and the public view the coal system (i.e. how net benefits are perceived) and what approach is followed vis-à-vis the development options for the industry.

Two broad approaches are possible. Under the first, policies could be chosen which would ensure that the Canadian coal system can meet foreign and domestic demands *as they arise* by addressing and alleviating non-economic constraints on the production, transportation and end-use of coal. This approach might be thought of as letting coal follow the system. On the other hand there are circumstances in Canada where coal can be seen to drive the system. That is to say developing the coal industry is seen as a means of increasing its contribution to the Canadian economy on a regional basis. In this latter sense opportunities associated with Canada's coal resources are exploited in anticipation of foreign and domestic demand (subject to provincial and federal energy and general economic development objectives).

In a regional context the development options for the industry are varied as coal producing and consuming provinces seek to incorporate coal into their existing but different energy supply systems. The advantages of coal to specific provinces are outlined in the "Regional Considerations" section of this paper.

There are several areas in which provincial-federal interactions may facilitate and support the efficient and economic development of the coal option. In some cases the interactions may be regionally specific while in other cases actions may apply in two, three or all coal producing and/or consuming regions. While further discussions will be required before all the concerns can be prioritized, the following are some of the initially identified issues: (A list of coal-related technological improvements has already been presented in Table 7.)

- Role of the federal and provincial governments in following coal exports;
- Construction of transportation infrastructure that would adequately support an expansion of Canadian coal production;
- Question of foreign investment in, and the access of, foreign countries to the liquids or gases produced from the coal;
- Co-ordination of federal, provincial and international environmental regulations and guidelines;
- Co-ordination of federal and provincial coal reserves and resource assessment programs;
- Support for R&D activities in the field of coal;

- Export of electricity from dedicated coal-fired generation facilities;
- Increased coal R&D in regional laboratories; and
- Financial and technical support for demonstration-scale facilities particularly those necessary to demonstrate advanced coal-to-electricity and liquefaction processes.

With respect to the disposition of production, developing an industry essentially to produce coal to meet export requirements is, in a certain sense, a special case of pre-building an energy supply option provided, of course, the resource base remains adequate to support expanding production. If Canada possesses a strong and growing coal sector, it can call upon this industry to meet domestic coal requirements should such needs arise. From the point of view of the importers of Canadian coal, it is noteworthy that only a small percentage (9%) of the primary energy supply for our domestic economy is derived from coal, a situation which is in marked contrast with that of most other coal-producing nations who are much more dependent internally on coal than are we. For this reason Canada is perceived to be a secure source of supply by importing countries. Against this background the key questions that must be addressed are: How should Canada develop its coal option as the new international market for thermal coal emerges? Should it continue its present essentially open policy? What gains or losses might result from changing this policy?

The issue of coal transportation also presents choices. For example, the Canadian coal producer has access to a modern and efficient rail transportation system, but it is a transportation system over which the coal shipper has almost no control. This situation is in marked contrast with that of oil or gas producers who, following the discovery of an important reservoir, normally construct a pipeline owned by themselves and sometimes other partners, which is operated on a cost-of-service basis with non-discriminatory access. The nature and size of the facility and its operating management are in effect decided by the owners of the resource who must, of course, also satisfy the relevant regulatory authorities. In a similar way the railways of Quebec and Newfoundland are owned and controlled by the iron ore mining companies. Thus a dedicated transportation system exists in that case as well. How then should Canadian coal be transported? Should there be a change in the nature of the Canadian transportation system to allow these more flexible management systems to apply to coal?

New coal transportation techniques must also be considered. Water-coal slurry systems are already in operation in other countries, and other systems are under study. For example, in Canada the existing oil pipeline network offers the unique option for considering oil-coal slurry pipeline systems (although further technological research is still required in this case). New transportation systems may offer opportunities for novel ownership and organizational relationships, and this could be important for some segments of the Canadian coal industry.

Canada must also come to terms with the options that it faces in coal technology. New forms of organizations or even new institutions capable of funding at much higher levels than the current expenditures on coal R&D may be needed to deal with developing new applications for coal and novel ways of transporting it to the stage where applications can proceed, and also to conduct the technical studies required to assure Canadians that increasing quantities of coal can be produced and consumed safely with minimal damage to the environment. Much of the more conventional research into mining and beneficiation requires strengthening. Other major coal-producing nations now make expenditures for coal R&D that are much higher than Canada's. This reflects the construction and operation of a growing number of expensive facilities around the world, which were built to demonstrate the new technologies. It is the potential users of coal who are most interested in these new technologies; the coal production industry need not be directly concerned. Some of the provinces interested in coal are now creating organizations capable of funding such developments. In general, these organizations are structured in such a way that they can hold and manage intellectual property (patents and know-how) effectively. International agreements within the IEA research and development structure and improved bilateral agreements with our international partners are also important routes for the acquisition of technological information. But the problems remain: How can Canada best gain access to the technology now being developed elsewhere? How should the expensive demonstration programs that may be needed in Canada be funded and organized? How should we acquire technology for general Canadian use from investors from other countries interested in building coal conversion facilities in Canada? It is clear that much more study of these questions is needed.

The available evidence suggests that the costs of producing liquids from coal for use as transportation fuels will be greater (or at least not less) than the cost of producing these liquids from the oil sands and heavy oils of Alberta and Saskatchewan. But the cost of producing liquids from coal should not be greater in Canada at the best sites than at those in other countries. While independence from imported oil is possible for Canada within the decade, we may wish to keep coal as a security option. This could be done by accepting foreign investment in the construction of facilities to produce oil from coal in Canada, but under terms negotiated such that, should the oil derived from coal be needed in the Canadian economy, a portion of the output would remain here. If none were required, all could be exported. We could examine proposals for the production of liquids from coal in Canada on a case-by-case basis, and negotiate terms for the export of the liquid product to other nations depending upon the level of investment and technical effort within Canada as exceptions to our normal controls over the export of liquid fuels. If a suitable agreement could in fact be reached with investing importing nations, then it is possible that

major installations would be built in Canada to establish an important new synthetic fuels industry which could be expanded to supply liquids to the Canadian market if need be. If it is not possible to negotiate agreements of this kind, then the option is for Canadians to develop an industry of this kind on their own, which will prove difficult especially in the early years, since the cost of the product will be more expensive than the product from the oil sands, and likely at first to be even more costly than imported oil. In short, how should we deal with the possibilities for the production of liquids from coal in Canada? How should we take into account our needs for adequate levels of Canadian ownership, select the new technologies required, and pursue the development of new technologies in Canada by Canadians?

Canada has choices to make in how it views coal; but in any option, Canadian coal has an important role to play in both the domestic and international energy systems. Domestically, coal can substitute for oil in traditional and new end-uses. In this role, it can not only fill in foreseeable gaps in Canadian energy balances, but it can add resilience and a capacity to absorb unanticipated shocks to the domestic energy system. It can also contribute to the resolution of Canada's most intractable energy problem, the indigenous supply of transportation fuel. In a regional context coal may serve as the basis upon which to build local economies.

But the Canadian coal system also has an important international role. In the near future, no later than the mid-1980s, a fully articulated international market for energy coal will be operating. How Canada chooses to react as a supplier in this emerging international energy coal market will have not only important implications for the stability of that market but also important implications for the resilience and depth of Canada's own energy supply capabilities.

GLOSSARY OF RESOURCE AND RESERVE TERMS

Coal Resources

The term "coal resources" for purposes of this paper is defined as the coal that is contained in seams occurring within specified limits of thickness and depth from the surface.

Assurance of Existence

The terms "measured", "indicated" and "inferred" denote the level of confidence with which given quantities of resources have been determined or estimated; they are defined as follows:

Measured resources are resources for which tonnages are computed from information revealed in outcrops, trenches, mine workings and boreholes. The spacing of points of observation necessary to justify confidence in the character and continuity of coal seams differs from region to region according to the character of the deposits and the geological conditions.

Indicated resources are resources for which tonnages are computed partly from specific measurements and partly from reasonable geological projections. For the general coal regions in Canada the spacing between observation points are usually twice as far as required for computing the magnitude of measured resources.

Inferred resources are resources for which quantity estimates are based largely on broad knowledge of the geological character of the bed or region and for which few measurements of seam thickness are available. The estimates are based primarily on an assumed continuity of coal seams in areas remote from the points of observation used to calculate measured or indicated resources.

Feasibility of Exploitation

Resources of immediate interest consist of coal seams that, because of favourable combinations of thickness, quality, depth and location, are considered to be of immediate interest for exploration or exploitation activities.

Resources of future interest consist of coal seams that, because of less favourable combinations of thickness, quality, depth and location, are not of immediate interest but may become of interest in the foreseeable future.

Coal Reserves

Mineable coal is that part of the measured and indicated resources of immediate interest within a coal deposit, that can be considered for mining using current technology, and applying a broad economic judgment only to the mining method.

Recoverable coal is that part of *mineable coal* that could be recovered as a run-of-mine coal with current technology and at current market prices. The coal deposit must be legally open to mining, and the necessary infrastructure must be in place or could be amortized through coal sales.